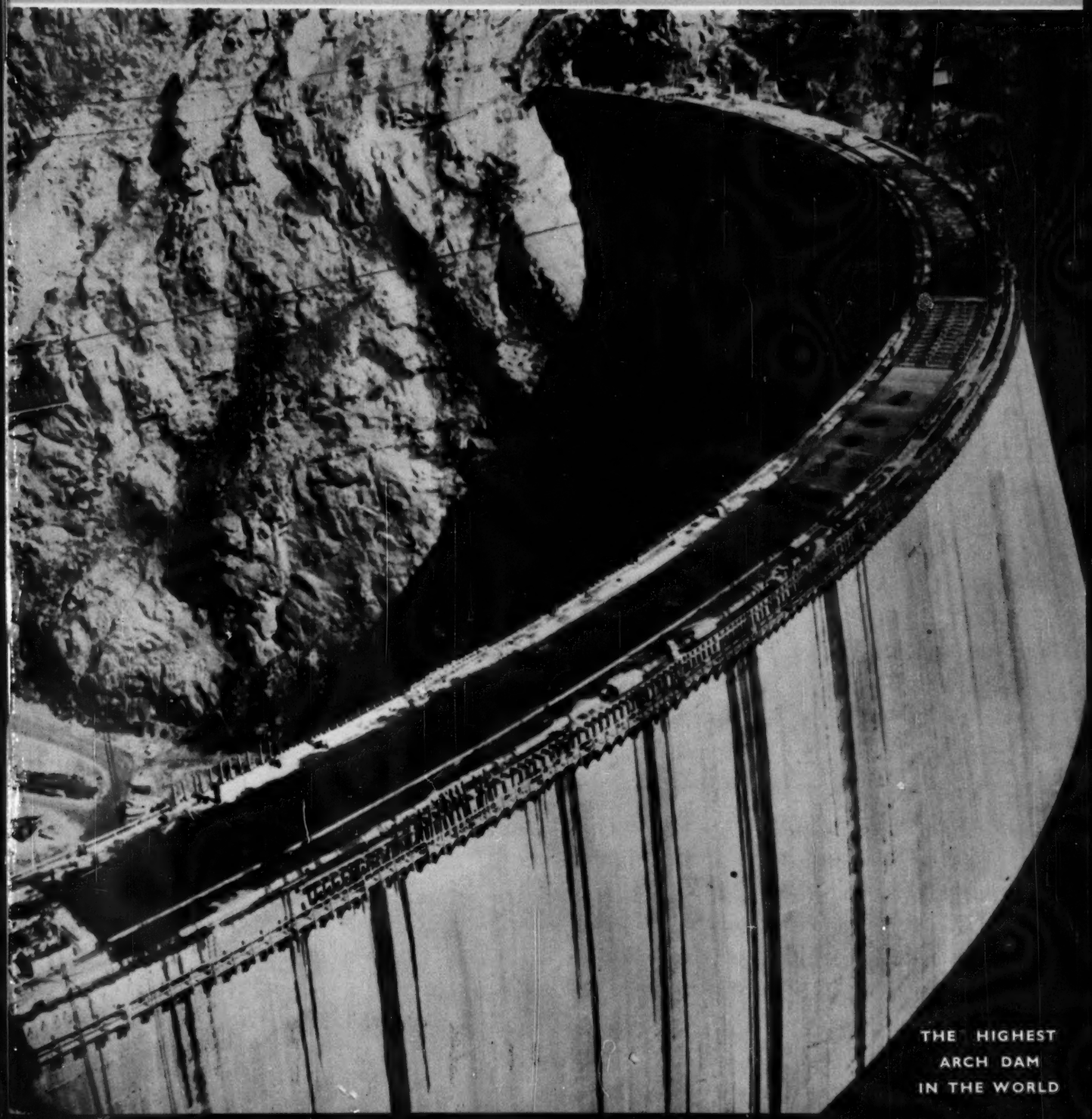
52

DISCOVERY

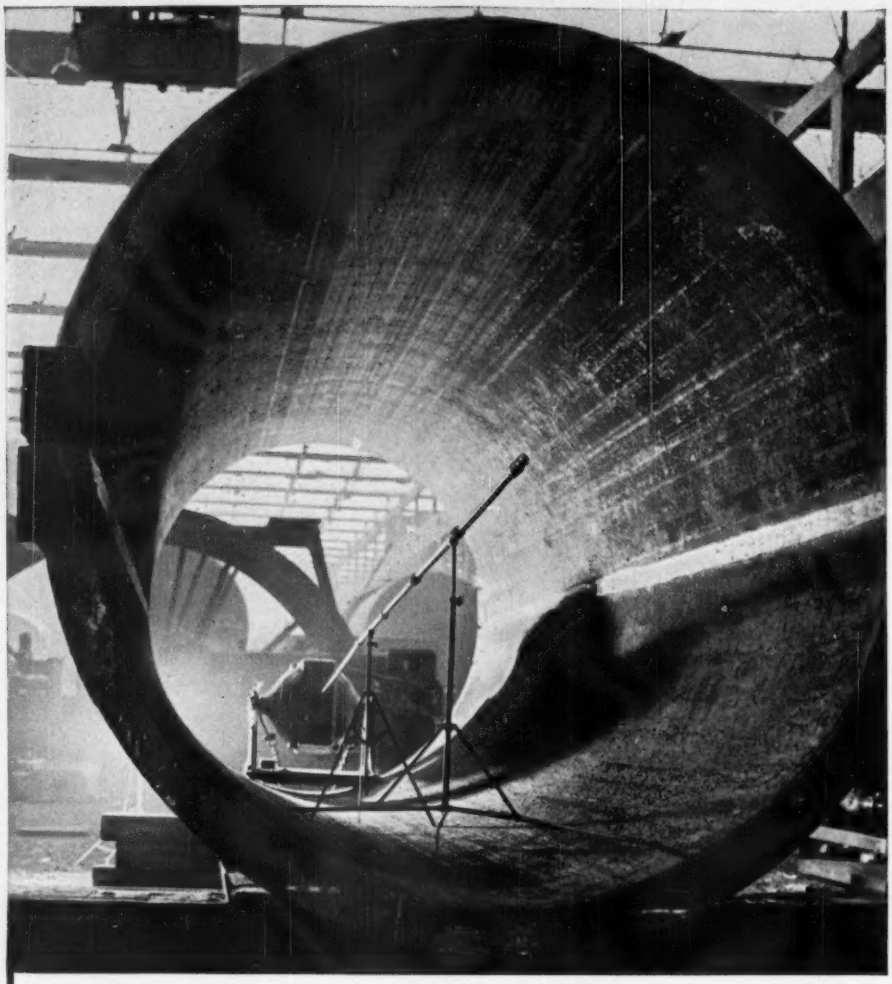
THE MAGAZINE OF SCIENTIFIC PROGRESS

SEPTEMBER 1958

2/6



THE HIGHEST
ARCH DAM
IN THE WORLD



Using a radio-isotope (contained in the axial tube) to radiograph the welded seams in a cylindrical pressure vessel. Ilford Industrial X-ray films, held in flexible cassettes, are attached to the outside of the cylinder. Reproduced by courtesy of G. A. Harvey & Co. (London) Ltd.

Photography in the Nuclear Age

More power for industry means increased prosperity for the nation. And so it is, as the programme for building nuclear generating stations goes ahead, that photography, with its partner, radiography, has a stake in Britain's future. For here is a vast co-operative effort in which many of the problems of research, design and construction depend for a solution on photographic methods.

Throughout the whole of this important field, Ilford sensitised materials render invaluable service which extends from helping to reveal the secrets of the atom to the vital task of testing the soundness of welded pressure vessels.

ILFORD

PHOTOGRAPHIC MATERIALS

ILFORD LIMITED · ILFORD · ESSEX

DISCOVERY

VOLUME XIX SEPTEMBER 1958 NUMBER 9

Editor
Anthony R. Michaelis, PH.D., B.SC.

Editorial Office
244 High Holborn, W.C.1
CHAncery 6518

Subscription, Distribution and Business Communications to
Jarrold & Sons Ltd, Norwich
Norwich 25261

Advertisement Office
Aldridge Press Ltd,
27 Chancery Lane, W.C.2
HOLborn 8655

OUR COVER PICTURE

Mauvoisin. The Highest Arch Dam in the world. The dam is part of a large-scale hydroelectric scheme now under way in Switzerland. It is 777 ft. high and has a total capacity of 352,000 kW. The article on p. 377 fully explains the building of it.

CONTENTS

The Progress of Science 355

Double or Quits
Science and Abstract Art
At Last: Railways Install Computer
A Progress Report on Cancer
The Centenary of "Gray's Anatomy"
Structural Wind Damage
ICSU, CETEX, SCAR and SCOR
The Problems of Alcohol

Science and Business: A Balanced Partnership 366
(*Presidential Address to the Glasgow Meeting of the British Association*)
Sir Alexander Fleck, K.B.E., F.R.S.

The Sensory Effect of Essential Oils 373
Dr Emil von Skramlik

Mauvoisin—the Highest Arch Dam in the World 377
H. R. Fiechter

Vitamin B_{12} 384
Prof. A. W. Johnson

Stature and Mental Faculties 386
Prof. Eugene Schreider

The International Geophysical Year: Month by Month 388
Angela Croome and Irene Nicholson

The Bookshelf 390

Science on the Screen 396

Pins and needles . . .

. . . bridges and bicycles,
we see steel in use all around us.
Steel that has to conform to strict
specifications, to ensure that its qualities
are suitable for its purpose.
Steel contains small quantities of such elements
as carbon, phosphorus, and sulphur;
upon which the properties of the steel depend.
Because of this, it is essential that
the exact amount of these elements present
in the melt should be known just before
it is poured from the furnace.
That is why so many steelmakers rely
on the spectrograph for their analyses.

¶ The illustration shows a Hilger automatic spectrograph that determines the carbon, phosphorus, and sulphur in steel in a minute and a half. It operates in the far ultra-violet region, and uses fluorite optics housed in a vacuum chamber to prevent absorption of the rays.

HILGER & WATTS LTD

98 ST PANCRAS WAY, LONDON, NW1

Our technical
advisory service
is freely available
to assist you in

making the most of lead

LEAD DEVELOPMENT ASSOCIATION
18 ADAM STREET, LONDON, W.C.2
TELEPHONE: WHITEHALL 4175
TELEGRAMS: LEADEVEP, RAND, LONDON

University Correspondence College

Founder: William Briggs, LL.D., D.C.L., M.A., B.Sc.
Principal: Cecil Briggs, M.A., *M.C.*
Vice-Principal: Arnold Saxelbye, M.A.Camb., B.A.Lond.
Arts Director: P. G. Hall, M.A.Camb.
Science Director: George Walker, Ph.D.Camb., M.Sc.Syd.

Tuition by Post

- U.C.C. provides Courses of Study in **Biology, Botany, Chemistry, Geography, Geology, Physics, Mathematics, Zoology, Languages,** and many other subjects. Full tuition is given also for **GENERAL CERTIFICATE OF EDUCATION** (all Levels) London, Oxford, Cambridge, Northern Universities, etc., **LONDON UNIVERSITY B.Sc.** (General or Special), **B.A., B.Sc.(Econ.),** and various other External Degrees.
- The College, founded 1887, is an Educational Trust with a staff of highly qualified Tutors, and the moderate fees may be paid by instalments if desired.

★ **PROSPECTUS** post free from the Registrar,
48 BURLINGTON HOUSE, CAMBRIDGE

THE PROGRESS OF SCIENCE

DOUBLE OR QUITS

Since the Government announced in 1956 plans to double Britain's annual output of scientists and technologists by 1970, popular awareness of the importance of scientific education to our future has grown. National pride was stung by the realisation that Britain was falling behind in the industrial and scientific race; thus, figures such as the following are becoming increasingly familiar. In 1955, Great Britain produced 106 scientists and 134 technologists per million of population, a combined total of 240 per million, compared with the U.S.A.'s 280 (143 scientists and 137 technologists), and the U.S.S.R.'s 508 (178 scientists and 330 technologists). Although recently much progress has been made in enlarging our scientific manpower, we conceive it our duty to focus attention on those areas which are most critical for the achievement of our aims and objectives.

It is one thing to lay down a theoretical target for expanding our scientific manpower; it is another to ensure that the buildings and equipment are available and, in a free society, to be certain that the teachers and students come forward. Even so, we must recognise that there is a definable, if imprecise, relationship between the rate of increase of industrial production and the number of engineers and scientists employed in industry. Thus, if Britain is to sustain an average increase of 4% per annum in industrial production, the current annual output of about 12,500 professionally trained scientists and engineers will have to rise by a further 7500 over the course of the next ten years. The achievement of this target depends upon a host of interrelated factors.

First, the universities. Whether they can play their part in providing 11,000 science graduates annually by 1970, in place of 6500 in 1955–6, will depend not only on their physical expansion, but on the situation in the sixth forms at schools, which will have in turn to grow even more rapidly. The situation in the public schools will be particularly decisive because the sixth-form element is proportionately greater than in the State schools, and the bias towards the Arts is more marked. Moreover, the public schools' "agonising reappraisal" towards science, and British industry's financial aid to them for scientific education, may not take effect in time. There is the contrasting danger, partly due to the "bulge", that the rate of expansion in sixth forms generally is faster than that justified by university expansion, so that the competitive pressure for university places will be aggravated. Thus, many sixth-formers, faced in addition with the growing shortage of science teachers, will wonder whether longer school education is worth striving for.

The current expansion of technical colleges, including the creation of colleges of advanced technology, could help reduce the number of disappointed sixth-formers. For although the universities must carry the major burden of expansion, the technical colleges' intake capacity for advanced courses for each year is scheduled to rise from 9500 in 1956 to 23,000 by the late 1960's, of which 10,500 will emerge as *fully qualified* scientists and engineers. All this must depend on a phenomenal increase in the number of students taking "sandwich courses" in engineering and applied science; hitherto this has been on a modest scale; indeed, over a year ago the number for the whole of England and Wales amounted to 3400. The outlook for "sandwich courses" is not merely a matter of providing places, but of industry's willingness to release the students, and the students' willingness to complete their studies without undue wastage.

The problem of the supply of science teachers is even more intractable. It is difficult enough in the technical colleges, where the majority of teachers are "part-timers". It is not far short of critical in the school system itself, and most acute in the secondary modern schools and girls' schools generally—important reservoirs of scientific manpower.

Another factor upsetting our delicately balanced manpower budget is emigration. Previous forecasts have assumed that as many as 20% of the annual output of scientists and engineers would not remain employed in the United Kingdom—admittedly, this figure includes foreign students, and women graduates leaving employment through marriage. Recent estimates, however, suggest that even this allowance is too conservative, as the emigration trend, especially among post-graduate chemists and physicists, and also engineers, is rising.

Whether our manpower aims are in themselves adequate raises further questions. Is a 4% increase in industrial output, to which our manpower target is tailored, too modest? Would this target not have to be higher to make provision for an adequate scientific "manning-up" of Britain's more backward industries? Where is the manpower for a more ambitious programme to come from? Signs of a lack of cohesion in policy are multiplying. Industry bids the universities produce still more scientists now that the shortage of science teachers in schools is worsening; the Government cherishes the belief that industry will somehow release scientists for teaching. There will have to be profound changes of outlook; there is the question of selection in the schools which, aggravated by social attitudes towards early leaving and further education, leads to a major loss of university talent; there is the character of our apprenticeship system, which produces far too few craftsmen eligible for further training; there is the social attitude to science in general, still most marked in parts of the Establishment (Oxford boasts fourteen chairs of history but only one of engineering) while there is the slow progress in modifying the virtually ascientific character of humanistic university courses.

Clearly, we welcome the positive achievements of recent years, but there is much cause for disquiet. This does not mean that we should be defeatist. Training new scientists is not the only solution. Our difficulties make it the more imperative to make the very best use of the scientists we have, for our existing cadres still vastly outnumber new recruits. Is it therefore not incumbent on a society which lays such emphasis on the training of new scientists equally to ensure by scientific appraisal and methods that its precious reservoir of scientific manpower is used to best advantage, both in industry and Government service?

SCIENCE AND ABSTRACT ART

The dispute between "abstract" and "representational" art has been going on, with ups and downs, for a very long time. It is never likely to be resolved, first because the problem is wrongly put, and secondly because it is as much a problem for the scientist as for the artist, yet the scientist is not consulted. As Henry Moore has pointed out, to whichever school the artist belongs his problem remains basically the same: to express, through *form*, a particular emotion. Let us say that the artist wants to express tenderness. Whether he is modelling a man's hand resting on a woman's shoulder, or two abstract shapes, the aesthetic problem (that is, the problem of how to externalise the emotion in structure and form) remains the same.

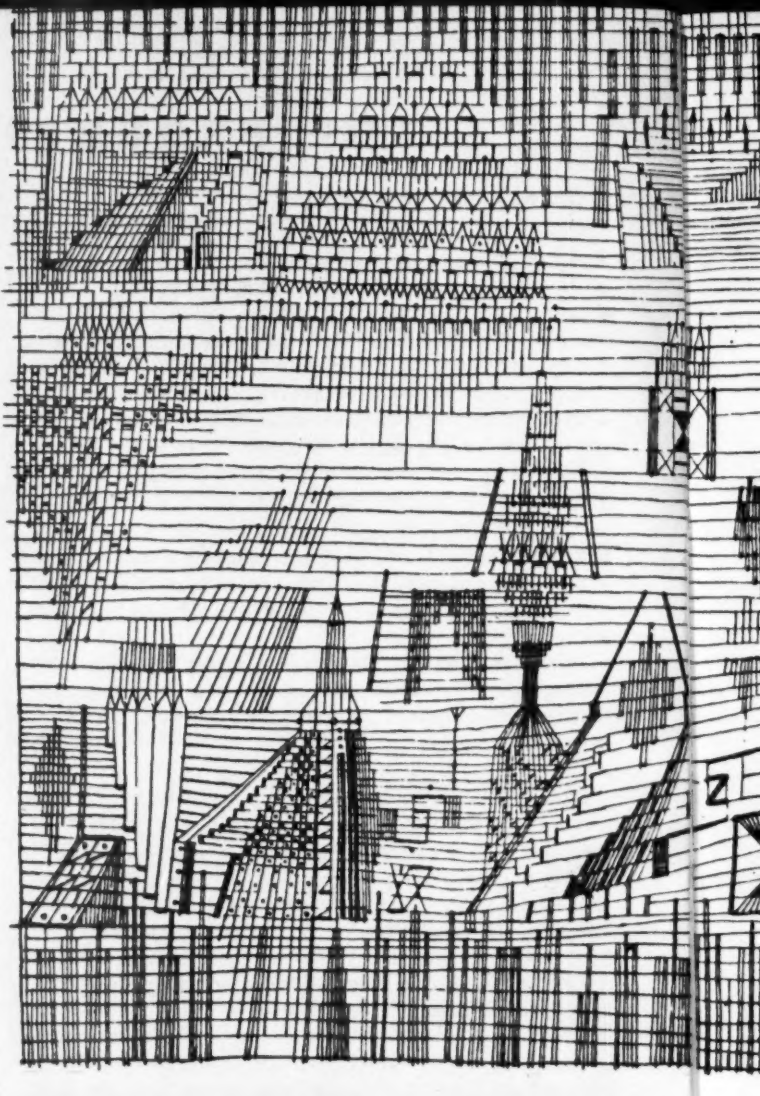
The whole question is wrongly formulated because the protagonists have not asked themselves one simple question: can abstract art ever be really abstract? It is this question that needs a deeper inspection, and it is here that the scientist can enter and help.

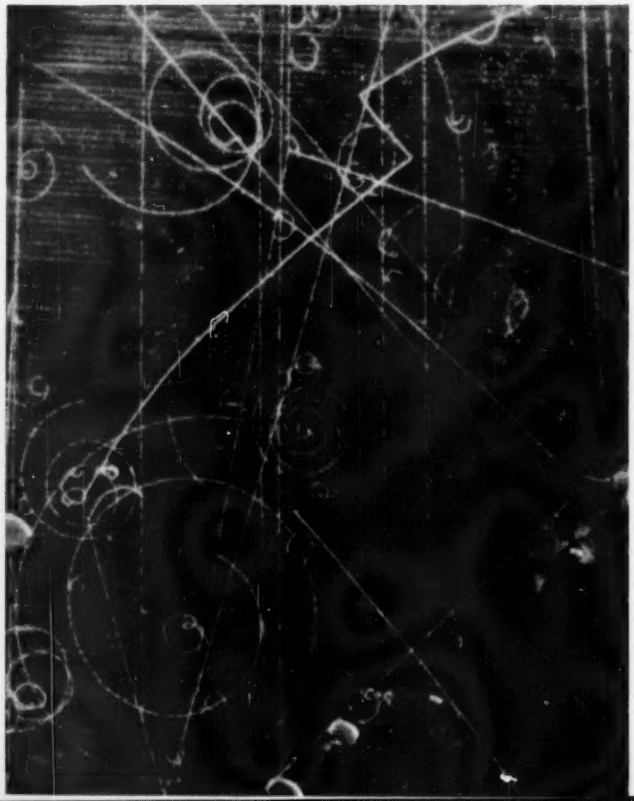
If a particular object in Nature is either too close or too far away for the human eye to perceive it entire, it begins to look to us abstract. For example, the network pattern of a honeycomb, if seen in the setting of a beehive, is recognised as honeycomb. The network of a wire fence seen against grass and apple-trees is seen as a wire fence. But if in either case the observer approaches closer, both honeycomb and wire fence become abstract patterns of geometry. Similarly, if we move far away from a landscape, up into the air, the cultivated fields begin to look like a chessboard. Everyone has at one time or another puzzled over the type of "photographic riddle" in which the observer is supposed to guess the real nature of some strange pattern—it may be the enlarged threads of cotton or wool, bolts on a conveyor-belt, or whorls of a seashell.

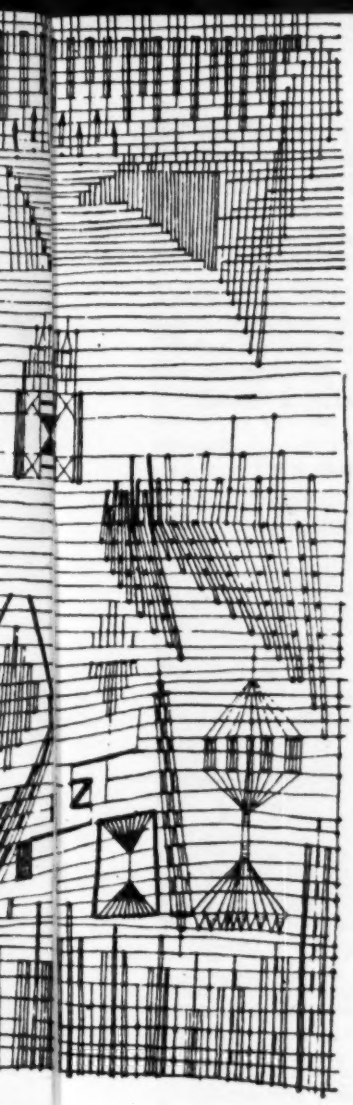
But it is not only proximity and distance which give this illusion of abstraction. Any object which is either too big or too small to fit into the human-sized world also looks abstract to us. Spiral nebulae, or the cells of our own bodies, are abstract patterns (see p. 358). The stretching of our sight-sense by telescopes and electron-microscopes extends the limits of this "world of abstraction" in two directions. It is in fact a perfectly real world, but of an unaccustomed size.

If we study these simple phenomena, we begin to see that the division artists have made between "realistic" and "abstract" is arbitrary. The difference is between ordinary sight on the one hand, and microscopic or telescopic sight on the other—between the mid-view of the cinema screen, the long-view, and the close-up. Whether deliberately, or simply through living in a world where microscopes exist—through having seen such shapes often enough in photographs, on cinema screens, or in fact—many artists have surely been influenced by modern scientific researches. (See p. 357.)

The real division is not between representation and abstraction, but between artistic creation and artistic invention if we use these terms in the following sense. Artistic creation must abide by the scientifically discoverable laws governing the creation of all things, from chemical elements to stars. The exact balance between proton, electron, and neutron—the atom being in a state of tension which ensures its shape and its existence—is an







SCIENCE OR ART?

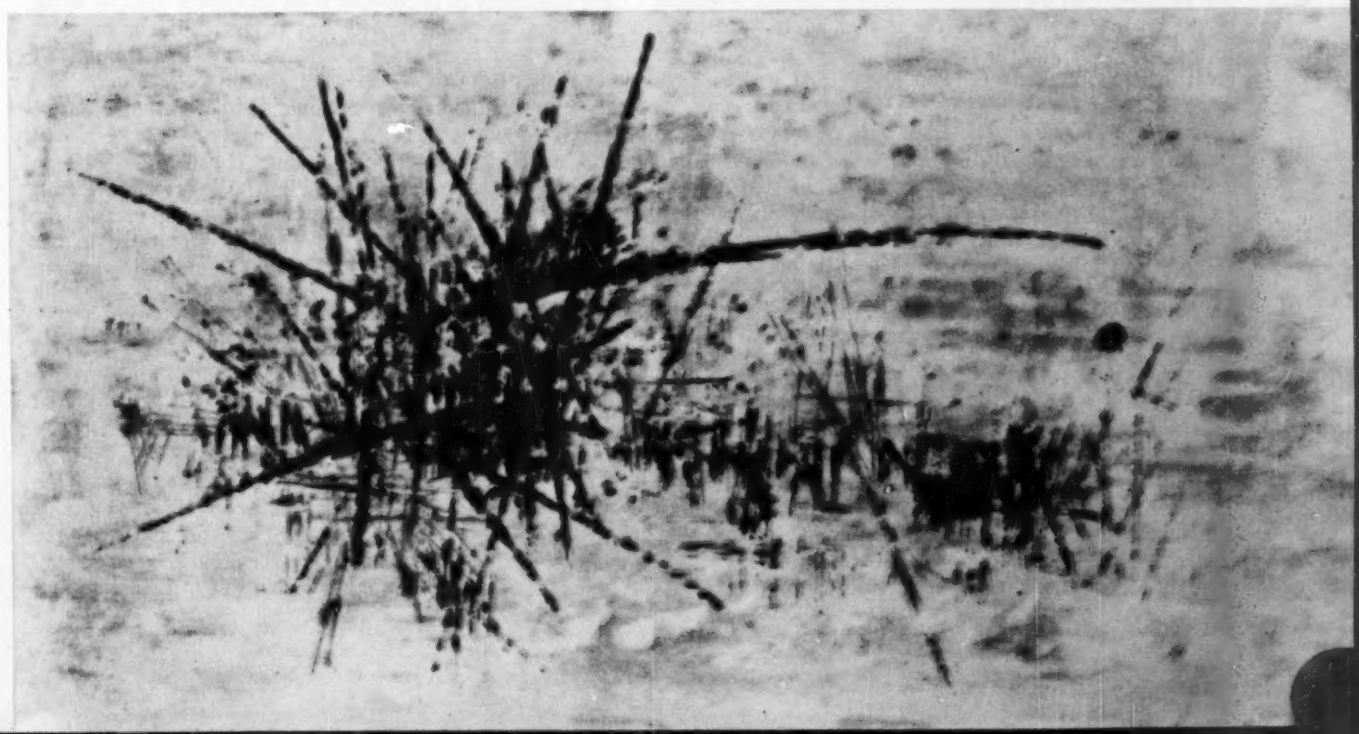
(*Left*) Paul Klee. Ink drawing: Air-Tsu-Dni, 1927. (From "A Dictionary of Abstract Painting". Methuen & Co. Ltd.)

(*Right*) Photomicrograph of an α-β brass (60% Cu-40% Zn). Magnification × 120.

(*Below, left*) Nuclear particle track photographed inside a bubble chamber.

(*Below, right*) Bernard Quentin, Composition, 1955. (From "A Dictionary of Abstract Painting".

(*Reproduced by courtesy of the Publishers*)



example. Another is the almost symmetrical growth of the human body and its relatively constant size and proportions even from race to race. Mathematical equations may be studied for further examples. So may the structure of molecules, the stresses within minerals, diamond, or iron, the growth of trees and leaves, birds' wings, and so on. Artistic *invention*, on the other hand, is the invention of something that never existed on land and sea.

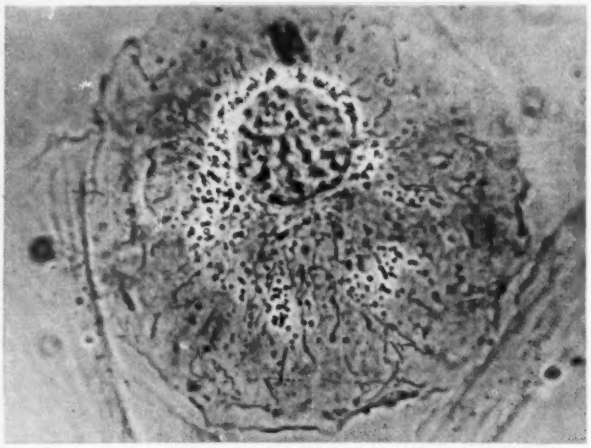
D'Arcy Thompson, in his book "On Growth and Form", drew attention to certain recurring patterns going through all organic life. These organic patterns must in some way be connected with growth, and they form the dynamic symmetry of all living things. The divine proportion, known to the Greeks, to the builders of Gothic cathedrals, to Giotto, and to a few other later European artists, is the formulation of this dynamic symmetry in terms of number. This divine or golden proportion is the proportion in which the diagonals of a pentagon bisect one another, and it is also the ratio between the diagonals of the pentagon and the side. A rectangle of the divine proportion, if the square of its shorter side is subtracted, leaves another divine-proportion rectangle; because of this infinite possibility of creating inner subdivisions, the proportion is naturally extremely useful in architectural design. It is the proportion in which the smaller term is to the greater as the greater is to the whole: *AB* is to *BC* as *BC* is to *AC*. Numerically it can be expressed as 1·618 . . ., generally symbolised by the Greek letter φ.

The properties of this proportion have been studied in modern times by a number of investigators, including Matila Ghyka (*see* "Geometrical Composition and Design", Alec Tiranti, London; "Le Nombre d'Or", Gallimard, Paris; "Geometry of Art and Life", Sheed and Ward, New York). Nevertheless, the practical application of the divine proportion remains elusive, because its presence in Nature has the quality of magic—and only a feeling for the patterns of growth can tell an artist exactly when and where to apply it.

All this refers to what may be called "creation"—and just as Nature herself cannot disobey the internal dynamics of the creative act, so an artist cannot afford to disobey them. Indeed it may be found on further study that the great artist is precisely he who knows and studies these internal dynamics—emotionally, intellectually, and as physical ebb-and-flow. The artist who ignores or scoffs at Nature's ways of construction may be said to *invent*—and it is only in this sense of *arbitrary invention* that *abstract* art can be said to exist at all. It soon becomes clear that, taken in this sense, abstract art can in no way compete with naturalistic art: *naturalistic* art being a restatement of any pattern—big or small—which already exists in Nature. The restatement must, however (and this is a vitally important condition), take into account the interplay of all the ingredients in the new event. If a green horse, or a bird made of stone, or a bronze woman, have never existed in Nature, then the artist must find out what would be the manner of growth of such a horse, bird, or woman if they were to exist. The problem for the artist is "how does greenness modify a horse?" "how does stoniness combine with bird-nature?" "what happens when bronze and woman fuse?"

Henry Moore (DISCOVERY, 1957, vol. 18, No. 6, pp. 249–51) has freely acknowledged that his string sculpture was inspired by seeing string models of mathematical formulae in the Science Museum in London. He says that after some experiments he abandoned this string sculpture because it became *too easy*: he could twist the strings here and there, and almost any combination produced a pleasing pattern. Suppose, however, that he had stuck to the mathematical formulae: then the making of string sculpture would probably have become steadily more difficult—not easier—because he would have had to make a thorough study of mathematics and of the visual expression of formulae in string.

CAN SCIENCE INSPIRE ART?



(Reproduced by courtesy of the Publishers)

A living cell. Microphage 1/300 in. in diameter seen through a phase-contrast microscope. Magnification × 2500. (*From "Scientists' Choice", by F. M. Branley; Basic Books, New York.*)

Henry Moore describes, too, how he saw a possibility of using the *supports* for the string models sculpturally—a matter which had not interested the makers of the string models in the Museum. He might have gone on to study the possibility of expressing some reciprocal formula in the supports, so that supports and strings could be made to complement each other mathematically, and not merely formally. But this he does not appear to have done, and therefore the experiment became, as he put it, "too easy". Henry Moore is an artist of great integrity, and he knows that anything easy is death to art. He therefore, rightly, abandoned the experiment. He might, however, have gone one step further and have found a way of making the experiment more difficult for himself. Returning to our "green horse" and "stone bird", what would be the laws of the relation between a string model and its necessary but extra-mathematical supports?

This brings us to another side of the story. Intellect plays its part, side by side with emotion, in all great art. But the kind of intellect that is required is not the kind that relies on rule-of-thumb: it is much more subtle. A very thorough knowledge of the laws of the natural world is first demanded, and here the scientist is needed to teach the artist: or else—as in the cases of Leonardo da Vinci or John Ruskin—the artist must turn scientist and study the natural world scientifically. Then scientific knowledge may light a spark of love for the created thing. Leonardo and

Ruskin both studied very closely and meticulously the varying shapes and behaviour under different conditions of clouds, rocks, waves, ripples in sand, and other such phenomena.

Only by the interplay of the scientific and the artistic can the artist discover the laws of the stone bird and the bronze woman. A bronze replica of a flesh-and-blood woman must always be less than life: why, therefore, trouble to make it? But a woman of bronze, created according to the pattern that would govern woman if Nature had made women in bronze, this is a new and independent creation worth the trouble of making. It is not, however—and this must be stressed—an *arbitrary* creation. Creation cannot be arbitrary. Only invention can be arbitrary.

An excellent "Dictionary of Abstract Painting" has appeared recently in France and in London (Fernand Hazan, Paris, 1958, and Methuen & Co., London, 1958, 304 pp., 42*s*.). Michel Seuphor, the author and compiler, has collected some first-class illustrations and makes many interesting observations. But what does appear odd is that, though the author is continuously emphasising the "modernness" of abstract painting, there are scarcely more than one or two passing references to the influence of science on abstract art. Yet surely this age, if it has any characteristic peculiar to itself, is pre-eminently scientific. The French artist Delaunay studied the spectrum, and one or two others have been fascinated by geometrical shapes and by crystals. Severini's manifesto on futurism written in 1913–14, which is reproduced in the "Dictionary", is worthy of study from the point of view of psychology, especially for certain remarks on the relationship of colour to sensations, to musical intervals, and so forth. He also deals with the effect of speed on our sense of space and time. The expression of speed in modern painting corresponds to a new vision.

The "Dictionary" quotes the Dutch artist Vantongerloo as having said, "Everything progresses and evolves, and the time is not far off when art and science will unite into a homogeneous whole." This idea was taken up by his countryman Van Doesburg, who wrote to a friend, "My final conviction, a conviction arising from the sum total of all my activities, is that in the future art will develop on a scientific basis. Until now the artist has always been at the mercy of his feelings and has had no means of controlling them. There was nothing to distinguish his methods of work from those of the milliner or pastry-cook, who merely arrange things according to their taste or inclination."

Valuable as many of the paintings illustrated in the "Dictionary" are, there is seldom evidence that they are not of the pastry-cook variety—delectable, but subjective. The practice of drug-taking, which some of these abstract-artists now use in order to free themselves from the domination of their habitual, *taught* ways of approaching any particular subject, does not in any way solve the problem of avoiding millinery and confection. Philip Toynbee, experimenting with mescaline, proved that it is possible to take these drugs and draw a complete blank. Under drugs there is, in fact, no control; and although it is evident that the control exercised by our conventional schoolings and ways of thought will not produce a work of art, this is no reason for condemning control as such. The control of an army sergeant-major is one thing: the control that built the Parthenon or Chartres Cathedral quite another.

And so we are led to the practical reason for this note: to suggest to artists, whether they are of the abstract or the representational school, that they study all the new forms unfolding beneath microscopes and through telescopes, in order to know better how things can grow and how they cannot, how they can affect each other under stress, and how they cannot. Only thus will representational art penetrate behind the accidental differences of things to their universal forms. And only through this study will "abstract" art find a discipline for otherwise arbitrary splashes. The artist will find, if he is honest, that Nature cannot be improved upon, but that it *can* be re-created in new and scientifically feasible combinations.

AT LAST: RAILWAYS INSTALL COMPUTER

The British Transport Commission have installed an analogue computer in the office of the Chief Electrical Engineer, British Railways Central Staff. The computer will provide advance details of train performance with the new forms of motive power which are being introduced under the railway modernisation programme. This information will be used to compile revised time-tables, designed for the maximum utilisation of electric- and diesel-powered locomotives and trains.

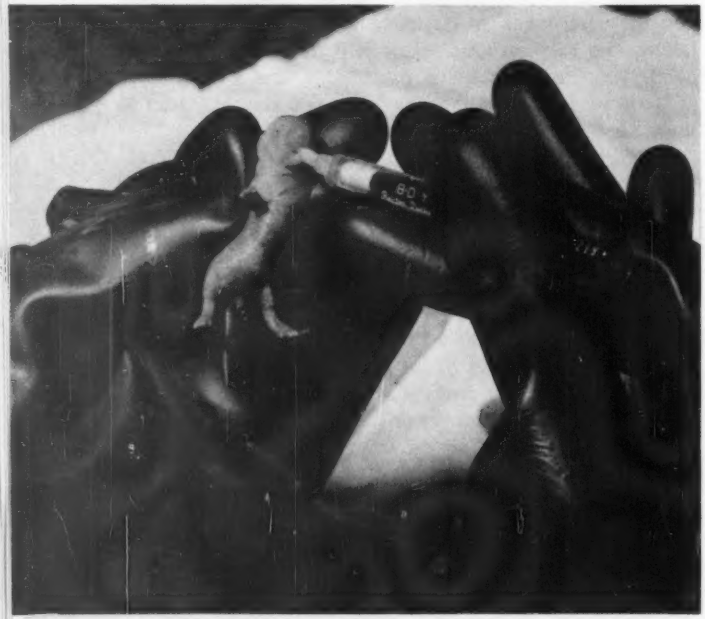
This type of analogue computer uses electrical voltages to represent the physical quantities concerned (accelerating and decelerating effort, speed, time, and distance). The computer was developed and built under the direction of Prof. E. Bradshaw of Manchester University in association with the Chief Electrical Engineer, British Railways Central Staff. With the aid of this computer, information can be obtained while the equipment is still in the design stage.

The analogue computer can rapidly produce a record showing the speed at which a type of locomotive hauling a given load, or a multiple-unit train, may be expected to be travelling at every point en route, the distance travelled, and the time taken to complete any part of its journey, taking into account time taken in periods of braking and accelerating, through speed restrictions, and during stops at stations. From this information it is a simple matter to build up freight and passenger train time-tables.

In the case of electric locomotives and trains, the computer can also provide details of the current consumed and an indication of the temperature which is likely to be attained by the electric motors in performing the whole or part of their work. Traction motor temperature is of particular value to the designer of the equipment as it enables the design of the traction motors to be matched to the duties required. Details of the current consumed by the electric traction motors of the locomotive or multiple-unit train in performing a particular run, are of importance to the railway electrical engineer. When this information is expressed in terms of all the trains covering a section of the line, an accurate assessment of the average and peak electric power supply requirements can be made.

Computers have for some time been in use by European and American railway companies and their introduction to British Railways is a welcome step in the modernisation so urgently needed.

Typical of the medical and biological research techniques used in the study of cancer and allied problems are these experiments with animals produced in a germ-free colony at the Lobund Institute, University of Notre Dame. (*Above*) Interior of the colony (see diagram on page opposite). The attendant who feeds the animals and cleans their cages enters through a germicidal bath after taking a shower in a germicidal spray. (*Below*) Animal being fed on a sterilised milk formula after birth by Caesarean operation. The formula is introduced into the stomach through a special rubber nipple attached to the syringe.



A PROGRESS REPORT ON CANCER

At a time when so great a proportion of all the money being spent on scientific research is being devoted to military purposes or on objectives that might have an eventual military application, it is gratifying to find a few really large projects that are engaging widespread attention and that would appear to have no warlike possibilities at all.

Cancer research has been described as the largest single co-operative scientific effort in history. Because cancer is a disease that is bound up with the most fundamental processes of life, research into the subject has developed along countless lines. Almost any knowledge gained about the nature of life itself, metabolism of cells, growth, antibody reaction, ageing, heredity, and genetics, could have a bearing on cancer. Among the many disciplines involved are medicine and surgery, biology, biochemistry, physics, biophysics, physical chemistry, pathology, cytology, statistics, veterinary medicine, radiology, organic and inorganic chemistry.

In many of the cancer research institutions there are fine examples of where workers from a number of these different disciplines work side by side instead of following the general trend of present-day science and working in highly specialised "water-tight compartments". The result has often been that this co-operation among workers of different branches of science and medicine has resulted in discoveries of great importance outside the immediate sphere of cancer.

In the United States, a country hungry for statistics, cancer as a killer yields place only to heart disease. There, as everywhere else, it knows no rival in one respect. Because of the many and often insidious forms that it takes it is man's most dreaded killer. Nor is fatal cancer confined to any special age-group. Its menace shadows us persistently from birth until we die. In the U.S., for children of 4 to 14 and adults aged 35 to 74, it is the second most frequent cause of death. The first cause in the case of children, incidentally, is not a disease at all; it is the motor-car. Thus, among diseases, cancer, with leukaemia, the cancer-like disease of the blood, really occupies first place. Only in those younger than 4 and older than 85 does it ever fall below third place as a cause of death.

The name "cancer" is itself misleading in a sense because it implies a single disease whereas it is really, in the view of most experts, a generic name applied to a whole range of diseases related to each other only by certain common characteristics.

Malignancy has been characterised as a disease of "cells gone berserk", that seem to have in most cases one sole objective: that of multiplication. In most cases they have ceased to have any other specialised function. This provides the histologist with one valuable clue to presence of the disease in many patients because organs that have been invaded no longer appear "organised" under the microscope. Multiplication of the cancer cells and a breakdown in specialised function following invasion of different organs will normally lead to the destruction of the host unless action is taken at an early stage, before the disease has had an opportunity to spread through lymphatic channels and/or the bloodstream to remote parts of the body and give rise to "metastases" or secondary growths.

Thanks to research that has already been carried out, the question: "What is cancer?" can now be answered in great

detail. It is much harder to say what causes it. Some blame mutations, hereditary changes in individual cells brought about by outside stimuli such as X-rays, radioactive substances like radio potassium that occur naturally in the body, or certain mutagenic chemicals. An increasing number of workers blame a virus as the cause in humans, as it has already been proved beyond doubt to cause cancer in some animals like the chicken, the mouse, and the guinea-pig. A few characterise the disease as an accidental fault in the normal replacement of cells by reproduction. This sort of mistake would be bound to happen on a purely statistical basis, considering the vast number that take place. As a variation of this theory, some believe cancer merely to be an unrestrained example of the normal healing process.

The full truth would seem to involve a combination of many of these theories. Knowledge that some cancers can be transmitted from one animal to another of the same species by virus-like particles has very recently been followed in Houston, Texas, and in Brussels by the isolation of a very similar particle in the tissue of human leukaemia patients. Other work tends to support the theory that such viruses may exert a mutagenic function by attaching themselves to the chromosomes of cells and behaving like genes in subsequent divisions.

The isolation of a virus might, of course, pave the way eventually to a vaccine valid against one or more varieties of the disease, as it might then be killed or attenuated and employed in the same fashion as those of influenza or poliomyelitis.

It is clear, however, that whether a virus is or is not the primary cause of the change in cell behaviour, it is not the whole of the story. Cancer only survives and thrives in humans and other animals whose resistance has already fallen below par. This may happen through irradiation with X-rays or other ionising radiation. The resistance may be destroyed by some chemical like nitrogen mustard that produces in the blood-forming organs the same effects as radiation. At other times it is pretty clear that the change is closely related to an unbalance in hormonal secretions. One of the most interesting discoveries is that body resistance to cancer seems to be related to the presence of a blood protein called properdin.

If sufficient supplies of properdin could be isolated from the blood of healthy patients or, better still, if ways could be found to synthesise it, then a way might be found to protect people against the disease or assist them to defeat it if it occurs.

Another promising method of controlling the disease, in this case one that is already being applied on a limited basis, is "chemotherapy", the use of chemical agents. These can take many forms but the selection of agents is always made more difficult by the fact that malignant cells, however different their outward appearance may be, apparently contain no chemicals not contained by normal cells, nor can they be distinguished by any chemical deficiency.

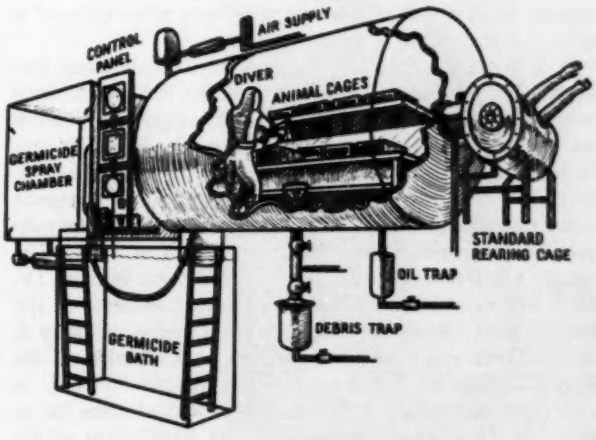
The only differences that have been detected are those of quantity. It has, for example, been shown that malignant cells, because they are in a multiplying phase, contain more of the nucleic acid RNA. This fact has been turned to good effect by workers like Ludwig von Bertalanffy, who have used dyes like acridine orange, which produce orange or red fluorescence in RNA, and green fluorescence in DNA, to give warning when specimens such as the vaginal smear, contain abnormally large proportions of RNA. In such cases it has often been shown that the RNA was due to the presence of malignant cells.

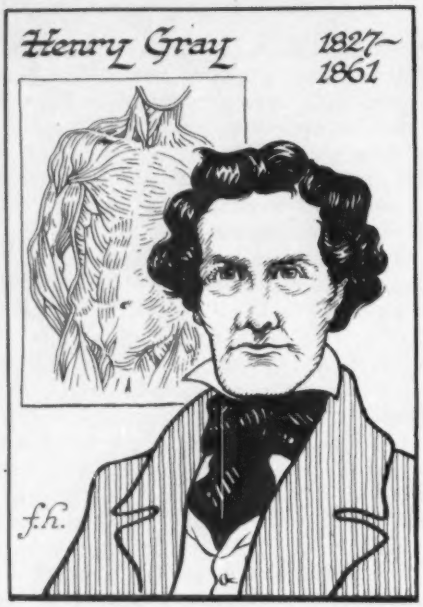
The fact that the malignant cells are rapidly reproducing opens up one further possibility that has been used to good effect. This is interference with the synthesis of new protein. Two important synthetic processes involve the purines and folic acid, and so-called "anti-folics" and "anti-purines" are widely used to "block" the natural synthetic process and provide some of the greatest hope.

Three of these, Methotrexate, DON, and nitrogen mustard, for example, have produced striking regressions in the treatment of the rare but previously lethal choriocarcinoma, a cancer originating in the foetal membrane. They have also proved effective for a period against advanced cases of breast cancer that were beyond surgery and in leukaemia. Unfortunately, it would seem that the cancer cells are readily able to adapt themselves and synthesise the proteins they need in other ways.

A further useful application of these drugs and other related anti-cancer drugs has been in the role of "adjuvants", or aids to surgery. The application in this case is against stray cells detached from the main growth during the surgical removal of a growth. The adjuvant is injected into the body cavity in dilute form, or into a vein, on completion of an operation. Further injections are administered on the subsequent two days. The results in such cases have been good, but surgeons have always to bear in mind the fact that the same drugs that act against cancer have in different circumstances been the causes of cancer, at least in animals. Because of this, adjuvants are in most cases only being used in advanced, usually hopeless, cases.

This fact increases the hope that these or similar drugs may in the future prove useful in the control of early cases of cancer. At least one prominent U.S. surgeon has already declared that he considers the results sufficiently beneficial to prevent him depriving 50% of suitable patients of the opportunity to use the drug (as would be required if it were applied on a purely statistical basis) until its long-term effects were better known.





Henry Gray. (*Specially drawn for* DISCOVERY *by F. Horrabin*)

THE CENTENARY OF "GRAY'S ANATOMY"

Known to successive generations of medical students as "Gray's Anatomy", Henry Gray's "Anatomy Descriptive and Applied" was first published a century ago, in 1858. Those who consider modern book reviews colourless and dull sometimes sigh for the slashing notices of days gone by, of which the following is a striking example:

> "Mr Gray has published a book that was not wanted . . . It is low and unscientific in tone . . . compiled, for the most part, in a manner inconsistent with the professions of honesty which we find in the preface . . . A more unphilosophical amalgam of anatomical details, and crude Surgery we never met with."

After filling six closely printed columns with quotations intended to show that the author had merely paraphrased Quain and Sharpey's "Anatomy", the reviewer (*Medical Times and Gazette*, 1859, n.s. vol. 18, p. 241), calls the book "an example of debased compilation and unscrupulous assumption". How surprised he would have been had anyone suggested that it would still be in great demand a century later.

It is a curious fact that Henry Gray, whose name has been a household word in medical circles for one hundred years, should be a shadowy and elusive figure. We know so little about him and wish we knew more. Even the year of his birth is uncertain. According to the obituary notice in the *Proceedings of the Royal Society* he was thirty-six years old, when he died of smallpox in June 1861, but subsequent biographers give the date of birth as 1827. The son of a private messenger to George IV and William IV, Henry Gray was entered as a "perpetual student" in the pupils' book of St George's Hospital, London, on May 6, 1845. Three years later he qualified as a Member of the Royal College of Surgeons (he was elected F.R.C.S. in 1860) and was awarded the College's triennial prize for an essay on "The origin, connection and distribution of the nerves of the human eye and its appendages." He became F.R.S. at the early age of twenty-five and lectured on anatomy at his Alma Mater from 1853 to 1858.

The book on which his fame rests rapidly acquired wide popularity at a time when several excellent works on anatomy were in common use. It did not contain any new discoveries, but it presented the known facts more lucidly and more systematically than its competitors and excelled in the wealth and artistry of its illustrations. It was based on long hours of patient dissecting in which the author was assisted by Dr Henry Vandyke Carter, who was responsible for the very fine drawings. Gray's style of writing was not distinguished, but he was greatly helped by Timothy Holmes's literary skill.

The first edition of "Gray's Anatomy" had 750 pages and 363 illustrations, and sold for 28*s*. The current 31st edition, published in 1954 and edited by T. B. Johnston and J. Whillis, has 1565 pages with 1317 illustrations, and its price has risen to £5.

The publishers of the first edition were John W. Parker & Son, West Strand, London; their business was taken over by Longmans, who have been responsible for all subsequent editions. The Philadelphia firm Blanchard & Lea (now Lea & Febiger) acquired the American Rights from Parker & Son, and every American edition has been issued by this house. When the seventeenth American (semi-centennial) edition appeared in 1908, a reviewer particularly noted how few of the original illustrations had been displaced and how little the descriptive text had changed except for amplification.

ICSU, CETEX, SCAR, AND SCOR

From October 2 to 6 the International Council of Scientific Unions (ICSU) meets in General Assembly in the rooms of the National Academy of Sciences in Washington, D.C.

What exactly is this ICSU? And what does it do for science in the international world?

The first question is perhaps most easily answered by announcing what ICSU is *not*. ICSU (rhymes with "Fix you"), which was formed in 1931, is neither the creation nor the creature of UNESCO or any other agency of the United Nations. All these agencies are ultimately governed by the votes of their Member States; in other words, they are responsible to national *governments*.

Not so ICSU, which is responsible to two *non-governmental* masters—the learned academies of forty-three countries (such as the Royal Society of London, the Académie des Sciences of France, the Academy of Sciences of the U.S.S.R.); and to thirteen international scientific unions (of Astronomy, Geophysics, Chemistry, Biology, and so forth).

Every three years representatives of these so-called National Members and Scientific Members meet together in conclave, to sketch a programme of scientific endeavour among the scientists of the world: to be mapped in detail by the Executive Board, meeting annually, on which serve representatives of the scientific unions only.

This programme, it should be said, takes careful account of the governmental programme of UNESCO, under the terms of the formal agreement between ICSU and UNESCO which has been in force ever since the birth of the younger organisation in 1946. In other words, we avoid as far as possible treading on each other's toes.

Next, what does ICSU do? . . . At the moment, its major activity is the IGY, the first plans for which were laid by the Executive Board as far back as 1951, ratified by the General Assembly at Amsterdam in 1952, and executed since 1953 by a special committee of the Executive Board (CSAGI) under the presidency of Prof. Sydney Chapman, F.R.S.

There is no need to remind readers of DISCOVERY that the IGY must already be declared a resounding success; but what can be emphasised here is that this pioneer experiment in international scientific co-operation has demonstrated how eagerly world science responds to a project which has a potential above the threshold of an already existing world interest; and how for an administrative outlay of barely $100,000 a year one can trigger a world-wide enterprise with a global budget of hundreds of millions of dollars.

A second current activity of the Council is that of its *ad hoc* Committee on Contamination by Extra-Terrestrial Exploration (CETEX). Under the dynamic leadership of Marcel Florkin of Liége, CETEX is drawing the urgent attention of the space explorers to the dangers of spoiling the tenuous atmosphere of the Moon, or of repeating on Mars and Venus the sordid story of the radioactive contamination of our own atmosphere and oceans, or of accidentally importing earth-born life or pre-life to the Moon and planets, by the premature impact of unsuitably designed and unsterilised rockets, launched from the Earth in an excess of chauvinistic zeal. . . .

For the immediate future, there are two special committees already at work, both springing from the IGY.

The first is the Special Committee on Antarctic Research (SCAR), formed at The Hague in March 1958. On this Committee serve the representatives of all the twelve countries already actively engaged in the scientific exploration of Antarctica; and already we have seen the first fruits of the formation of SCAR in the agreement between the United States and Australia to run the Wilkes Station, on territory claimed by Australia, on a co-operative basis.

The second Special Committee is for Oceanic Research (SCOR). Here the main lines of the SCOR programme were laid down at Woods Hole in the autumn of 1957: namely, a study of the influence of the oceans on world climate; a study of the fertility of the sea; and an examination of the problem of the disposal of industrial radioactive waste in the Atomic Age. The test area for these studies will be the Indian Ocean, on which will converge the oceanographic vessels of at least twelve countries, over a complete monsoon cycle in 1962–3.

And other projects, planned by scientists in the interests of world science, will surely be forthcoming from this year's General Assembly of ICSU in Washington.

STRUCTURAL WIND DAMAGE

The forces exerted by wind can be among the most severe to which engineering structures are subjected during the course of their life. The prediction, evaluation and formulation of these forces can therefore have a significant influence on both the safety and economy that can be realised in the design of a structure.

At the suggestion of the Advisory Structural Group of the Associate Committee on the National Building Code of Canada, the Division of Building Research has begun a study of the action of wind on structures. The aim of the study is to make the formulation of design wind-load requirements more rational and precise and to this end to indicate what further research would be most fruitful.

Heretofore, the calculation of wind loads on buildings has been based upon the maximum computed gust speeds occurring during a thirty-year period and upon certain specified "shape coefficients" determined from wind-tunnel tests on models. Although this basis for wind loads was the best that could be offered at the time of preparation of the Canadian National Building Code, certain aspects of this procedure may be unrealistic.

The following questions are among those being studied by DBR: Can a better statistical interpretation be given to the prescribed design wind velocity so that it is associated with a probability of occurrence during the given life of a structure? How significant is the action of gusts on structures? Is the action of gusts dependent on the size of the building? How is the variation of wind velocity with height dependent on the topographic characteristics of the site? Are wind velocities as high in cities as they are in the neighbouring countryside?

In its attempt to answer these questions the Division of Building Research works in close co-operation with the Meteorological Branch of the Department of Transport, a member of whose staff has been for some years seconded to the Division. This close co-operation is necessary since the designation of design wind velocities is intimately connected with the behaviour of the structure itself. For example, the forces exerted by a gust on a structure are closely related to the size and shape of the structure and the duration and velocity gradient of the gust.

A programme of investigation of damage to full-size structures due to wind action has begun and three such studies have already been undertaken in Alberta, Saskatchewan, and Ontario. This should shed light on some of the more practical aspects of the problem which, when combined with the more fundamental aspects of the study, should yield improved wind load requirements for Canadian structural engineers.

A house damaged by wind in Saskatchewan.

THE PROBLEMS OF ALCOHOL

For nearly seven years the World Health Organisation (WHO) has been studying the dangers to human life caused by alcoholism. The WHO is now carefully considering a world survey, prepared by their leading specialist in this field, Dr E. M. Jellinek, which calls a bottle a bottle and should knock flat a good deal of the blind complacency and downright misrepresentation which stand in the way of social action.

The greater part of the medical and research literature on alcoholism, the WHO consultant points out, is of Anglo-Saxon origin. In these nations steady excessive drinkers are so much in the foreground that the term "alcoholic" is usually applied only to these drinkers. But Dr Jellinek maintains that international experience leads to the conclusion that, in many countries, problems of national magnitude arise more from other types than from the steady excessive drinkers.

The latter exist in every country, of course, where alcoholic drinks are consumed, but they may form a small group. In Finland, for example, alcoholic drinks are sold in urban areas only and the violence displayed by Finnish workers when they come to town from some isolated camps and have a few drinks causes such damage that, to the Finnish nation, this type of drinking constitutes alcoholism. Steady excessive drinkers in Finland (there are probably tens of thousands) resemble in their behaviour their American, British, or Swedish fellow-imbibers; but it appears ironic that the process of slowly drinking oneself to death presents less a social problem than the violence caused by the few occasional "explosive" or relief drinkers.

In Spain, recognised "alcoholics" are few, but the group of occasional excessive drinkers with dangerous behaviour is considerably larger. The damage caused by the latter may be violence (but this is by no means characteristic of them), industrial and traffic accidents, lowering of disease resistance, absenteeism, and over-spending.

The problem of "alcoholism" varies, naturally, from country to country. According to accepted ideas in the Anglo-Saxon countries and even in some Latin countries, occasional excessive drinkers (such as week-end or Sunday drinkers) would never be regarded as alcoholics. Treatment and preventive measures consequently differ in practice. Public care and treatment as advocated in the United States, England, and the Netherlands, for instance, does not make sense in the case of the week-end drinker, who follows a cultural pattern. Instead of applying the term "alcoholism" to all forms of excessive drinking, Dr E. M. Jellinek suggests in his report to the WHO, therefore, that medical men and sociologists should talk instead about the *problems of alcohol*. "Alcoholism" is only one of these problems.

Let us apply this approach to wine-drinking France. Here one frequently finds social science students using the term *l'alcoolisme sans ivresse* (alcoholism without drunkenness). It is asserted that a drinker can become an alcoholic without ever *showing signs* of intoxication. In fact, this opinion is held by the population at large. According to an opinion poll, 75% of the men and 82% of the women expressed the opinion that a drinker can become an alcoholic without ever getting drunk.

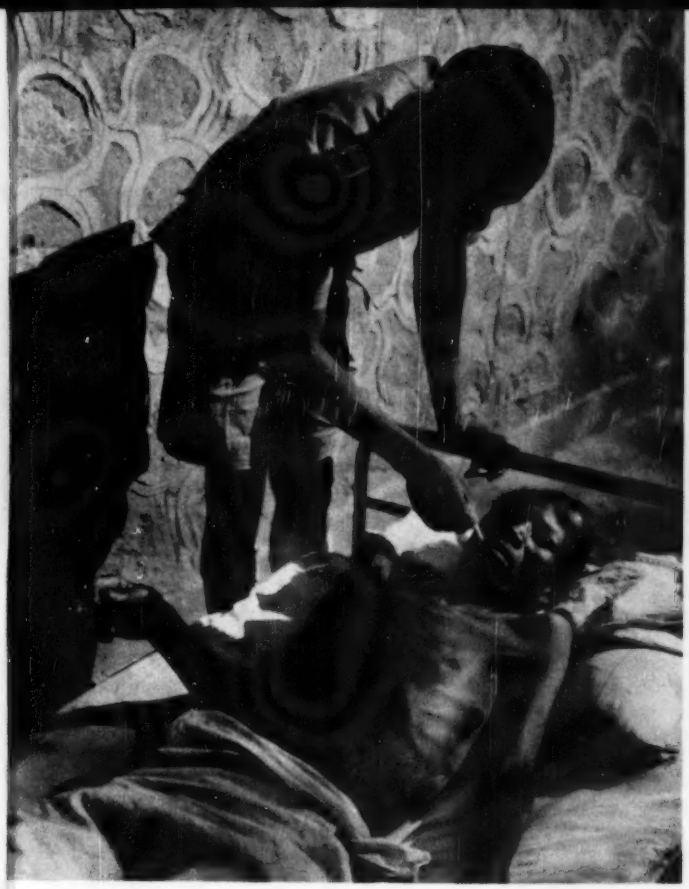
According to a research study conducted in 1936, 7% of French adult males drank daily amounts of 3 litres of wine or more. While it cannot be said that a given daily amount of alcohol will produce "alcohol addiction", there can be little doubt that the amounts of 3 litres of wine upwards per day, over fifteen or twenty years, cannot be handled by the normal organism without much impairment of metabolic and nervous functions. This can reasonably be classed as "chronic alcoholism", even though the ingestion of this amount over fifteen hours results in no overt intoxication.

To be specific, a French labourer may distribute a total of 3 litres of inexpensive wine, beginning with a glass at breakfast. He may drink almost hourly small amounts up to noon, when he may take about ½ litre with his lunch. This might well be followed almost hourly by drinks up to the evening meal, when he might take about a litre with a few small drinks afterwards. Under these conditions, according to Dr Jellinek, a drinker of average weight will hardly exceed a concentration of alcohol in the blood of 0·02%, between morning and noon, and his highest, after the evening meal, will be somewhere around 0·12%. Thus, his organism will hardly ever be free from alcohol, although the blood alcohol concentration will be at levels of "sobriety" during a large part of the day. In fact, a large proportion of French drinkers incur *chronic alcoholism* without having ever shown any characteristics of "addictive drinking".

In the ordinary layman's view, alcoholism becomes a health problem in those countries only after the excessive drinker develops an alcoholic disorder. On the other hand, the WHO investigation shows that, in many Anglo-Saxon countries, about one-third of the adult population reject the use of alcoholic beverages entirely, and the other two-thirds do not favour large individual consumption.

Comparisons may be odious, but no one can deny the economic origin of a great part of this problem. The vested interest in the production and sale of alcoholic beverages in some viticultural countries is of extraordinary intensity. Moreover, the economic insecurity of the individual and poor housing conditions (so common in France) induce the dwellers to look for a more pleasant environment in the taverns. In France, in fact, millions of its workers earn their living through the production of the raw materials, the processing and the sale of alcoholic drinks. The interests of all these groups, obviously, contribute towards a large consumption and tend to dominate public opinion through a variety of propaganda channels. Furthermore, an enormous wine production demands a large number of outlets. In France there is one wine outlet for each ninety-seven inhabitants, and the number of alcoholics increases as the number of consumers and the amount consumed increases.

As a first step to reach the public at large, WHO recently commissioned Philip Stapp to design and direct a film based upon the findings of its Committee on Alcoholism. This film, *To Your Health*, supervised by Dr E. M. Jellinek, is being released internationally and will be shown on cinema and educational screens and on television. It pronounces no judgment, but tries to state facts in a clear and understandable form and thus encourage intelligent and objective consideration of the universal problem of alcoholism.



(*Above*) The housefly is one of the most common enemies to public health, and one of the most difficult to destroy. It is a problem engaging the activities of scientists in all countries. Here a Shell research worker at Denver, U.S.A., is applying a minute amount of experimental insecticide to a fly during laboratory tests.

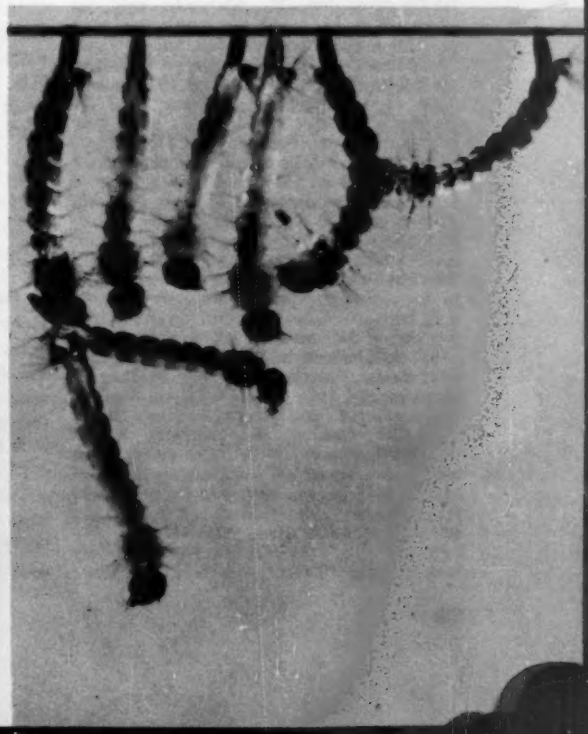
(*Left*) An African at Tabora, Tanganyika, suffering from Trypanosomiasis (sleeping sickness), a disease spread by the tsetse fly.

MAN'S FIGHT AGAINST TROPICAL DISEASE

Spreading insecticide into dense jungle against mosquitoes that do not enter houses is one of the problems that malaria teams are combating. A useful weapon is the fogging machine which these workers at Blakang Mati, Singapore, are employing in thick undergrowth.

Like an abstract pattern, these larvae of the *Aedes aegypte* mosquito hang upside down under water as they hatch. These mosquitoes carry the deadly yellow fever in many tropical regions.

(*An extract from a Shell Picture Story*)



SCIENCE AND BUSINESS: A BALANCED PARTNERSHIP

SIR ALEXANDER FLECK, K.B.E., F.R.S.

Presidential Address at the Glasgow Meeting of the British Association for the Advancement of Science

(ICI photograph)

Sir Alexander Fleck, K.B.E., D.Sc., LL.D., F.R.S. Sir Alexander, born in 1889, started his working life as a lab boy at Glasgow University, where, after three years, his keenness for continuing education enabled him to become a full-time student. By great determination he gained a chemistry degree at the age of 22 and an appointment on the University's teaching staff as an assistant in the Physical Chemistry Department. By 1913 he had his own research laboratory as Physical Chemist to the Glasgow and West of Scotland Radium Committee, where his work was concerned with radiological research on cancer. He gained his doctorate for a thesis based on work done in the university chemical laboratory entitled "Some Chapters on the Chemistry of the Radio Elements".

The vast and high-speed expansion of the British chemical industry during the First World War drew Sir Alexander into the Castner-Kellner Alkali Co., which became in 1920 a subsidiary company of Brunner, Mond and Co. The ICI merger in 1926 gave his talents wider scope, and by 1931 he had risen to be managing director of ICI's General Chemicals Division. Six years later he was appointed chairman of ICI (Fertilisers and Synthetic Products) Ltd., the predecessor of the Billingham Division of ICI.

Sir Alexander joined ICI's main board in 1944 as director responsible for the Billingham Division and also for Central Agricultural Control. Wilton—ICI's newest and most revolutionary development—was added to his responsibilities in 1946. From 1951 until his appointment as chairman in 1953, he was one of the company's deputy chairmen.

Sir Alexander's contributions to Science were twice recognised in 1953. In June of that year his Alma Mater, Glasgow University, conferred upon him the honorary degree of LL.D., and in the following month Durham University, with which he has close connexions, made him an honorary D.Sc. In March 1955 he was elected a Fellow of the Royal Society. He received a K.B.E. in the Birthday Honours list in June 1955.

Science

In a population which depends so much on science, it is sad to think how few people clearly understand what it is all about. It is an approach to an understanding of the universe along a broad highway of organised knowledge firmly founded on observation and experiment embedded in a matrix of theory. It is a highway which is constantly being widened and extended and repaired. We are building it because we think that by and large it is a good road for mankind to travel, and that it is leading him away from ignorance and wretchedness towards a fuller life and a better world. Some find that the act of extending the highway gives them all they seek from their life-work: these are the pure scientists and much of our progress derives from them. Others find greater satisfaction in utilising what has already been built, pausing perhaps to strengthen it here, widen it there: these are the technologists or applied scientists. A few people combine both functions, driving the road forward into undiscovered territory, then paving it ready for all to use. Whatever our own work may be, we have a joint responsibility to see that the highway is properly and extensively used by all mankind. It is therefore fitting that the British Association is now devoting itself to the additional task of securing the greater use of this highway by all types of people in these islands, more especially as we enter what is often called the Second Industrial Revolution.

In the First Industrial Revolution man learnt to convert chemical energy, derived from the reaction between carbon and oxygen, not merely into heat but into mechanical energy, steam being the key to the process. In the Second Industrial Revolution we are turning from the external properties of carbon atoms to the internal properties of the lightest and heaviest atoms in nature as a source of energy to expend as prodigally as we like, thus husbanding carbon atoms as a source of materials.

Another feature of the Second Industrial Revolution is the growing interdependence of the sciences as they advance on a broad front. To review the achievements of the last year or two alone, the launching of the Russian and American Earth satellites depended on prior developments in several different sciences and technologies. Chemical rocket fuels, refractory combustion chambers, and radio transmitters which despatched back to the earth information of great relevance to the theme of the International Geophysical Year, all played their part. Miniature transmitters themselves followed the invention in the Bell Telephone Laboratories ten years ago of the transistor, which in turn owes its successful development, at least in part, to the perfection of methods for separating traces of boron and other elements from silicon to a degree of purity exceeding one part in a thousand million.

All of us here recognise the creative possibilities of thermonuclear fusion energy opened up by the Harwell and Aldermaston experiments on high-temperature electric discharges. Although most of the neutrons so far produced have not originated from thermonuclear fusion, there can be no doubt that ZETA and SCEPTRE are symbols of man's reach into a future of boundless energy; his grasp of such a prize could well rank as his greatest material achievement in the history of the world. In such experiments as these, as indeed with the discovery of nobelium, a prerequisite of success is a flourishing electrical industry which can provide many of the tools of nuclear physicists.

Scientific effort on this scale costs money; indeed, the total annual research expenditure in this country alone is estimated to be £300 million. Such effort also costs scientists. Public expenditure on education (including the universities) is now some £740 million a year; if our universities are to grow large enough to accommodate everyone who could benefit by such an education, instead of merely the 3½% of the population who enjoy it now, then we shall need to contemplate spending something nearer £1200 million a year. These are large sums and if as a nation we are to stay solvent they can only come from one source, the wealth which we produce.

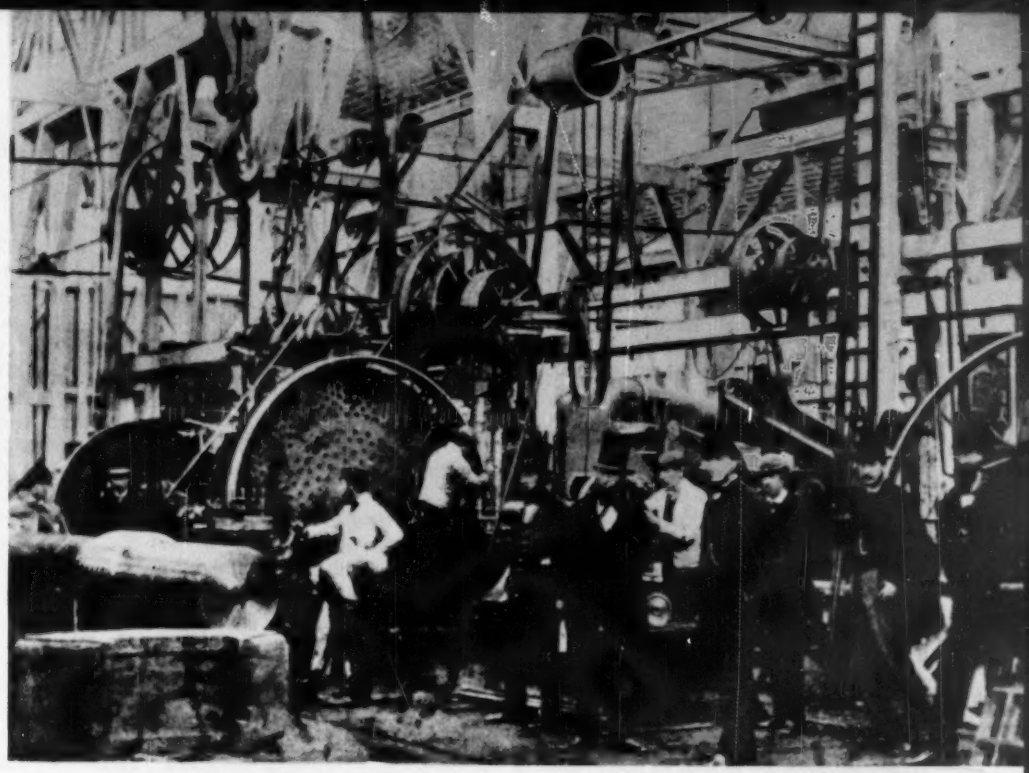


FIG. 2. **Inspection by the Board of Directors.** One of the earliest factory interior photographs, from the *Gernsheim Collection*, showing the heavy turnery at the Penn & Sons Marine Engineering Works at Greenwich (1863). It was then the biggest of its kind in the world, employing 1800 men.

Business

In this context it is easy to see the importance and responsibility of business, which produces and distributes most of our national wealth. Our capacity to extend our science and education largely depends on our ability to run business successfully. Lewis Mumford in his "Technics and Civilization" written in the 1930's, though he appears to exaggerate their numerical importance, suggests that it may have been no accident that there were merchants of the City of London who played a part in the early days of the Royal Society. He draws attention to the affinity of science and business when he writes: "The power that was science and the power that was money were, in final analysis, the same kind of power: the power of abstraction, measurement, quantification."

On an occasion such as this it is difficult to avoid being at once too general and too particular. I have chosen to speak of business because business is a more comprehensive term than industry. At the same time I intend to limit my scope primarily to the larger units, although naturally I recognise the importance of the smaller organisations—indeed, in manufacturing industry alone, three-quarters of all establishments employ fewer than 100 people.

Defining the limits of my subject in this somewhat arbitrary way will for the moment do service for a formal definition of the term "business". After all, it is a vague word, perhaps for euphemistic reasons in the past, even deliberately vague. Nevertheless, I venture to put forward three characteristics which I think a business should have if it is to survive and function effectively over a period of years.

First, it must contribute to the well-being of the community and its social evolution. I believe it can best do that in three specific ways: by producing goods or services for the community at fair prices; by giving fair treatment in the way of remuneration and working conditions to all who give their services to the business, whether as payroll employees, administrators, or scientific staff; and by giving a fair return to those who risk their money in the business, so that, apart from this consideration, they will be encouraged to provide again for further ventures. When business takes on itself the deployment of financial, material, and human resources, it also takes on, I believe, the responsibility for seeing that they are properly and effectively used. In other words, it has an obligation to the community; and only in so far as it fulfils that obligation does it contribute to the well-being of the community and justify its own existence.

Second, business must have the capacity to change its methods and if necessary even its objectives. It must be constantly alert to see that its products or services meet or anticipate the needs of the public, and to withstand the nipping and eager air of competition whether it comes from advancing techniques or from new entrants into the field.

Finally, if it is to be self-perpetuating through growth or modernisation, a business must dispose of its products or services for more than their cost—or in plain language, it must make a profit. That is true of business whether run by private enterprise or by the State; nor does the political system of the State make any difference to the validity of this notion. Only from the excess of income over expenditure can we finance the expansion of business and science.

This brings me again to the reason why I have chosen to talk about business rather than industry. It is an old saying that money makes money; by the same token the production of wealth requires the investment of wealth, and such investment can come from a variety of sources. Traditionally part comes from retained profits, that is from what economists in the past called the abstinence of the individual manufacturer, or in today's terms, from the undistributed earnings which companies plough back into the business. Part comes from the banks, though their function in this country has usually been to provide working capital in the form of loans and overdrafts, rather than to provide fixed capital like the industrial banks of Germany which played such a prominent part in the organisation and growth of industry in that country. Indeed, we can share Disraeli's surprise that the London money market played such a small part in the financing of the railways. In "Endymion", published in 1880, he wrote: "What is remarkable in this vast movement is that the great leaders of the financial world took no part in it . . . even Lombard Street which never was more wanted, was inactive, and it was only by the irresistible pressure of circumstances that a banking firm, which had an extensive country connexion, was ultimately forced to take the leading part

that was required." Today by far the largest volume of capital comes from the investing public as private individuals or financial institutions, working with a vigorous and well-informed Stock Exchange.

There is, of course, no exact relationship between the amount of income which a country ploughs back into capital formation and the rate of economic growth which it achieves. Nevertheless, I think that certain generalisations can be offered. For example, we can compare the experience of the United States with that of this country. Between 1870 and the First World War, the United States devoted more than one-fifth of its National Product to home investment, and the United Kingdom only about one-tenth. During that period its National Product grew by more than 4% per annum compared with less than 2½% here. More recent history, in spite of occasional and, one hopes, temporary setbacks here, suggests the same lesson: over the past forty years the United States has invested about half as much again in relation to its resources as we have, and its National Product has risen at an average rate of about 3% per annum, against only about 2% in this country.

I do not wish to strike a note of disappointment so much as to remind you of the classic virtues of abstinence, saving, and investment. In fact during the past ten years the amount which the United Kingdom has invested in its productive resources has shown an encouraging growth, with the apparent result that output in manufacturing industry, as a whole, has increased by some 3¼% per annum since 1948, compared with about 2½% between the wars. If science has laid the foundation for much of this expansion, business has provided the will and the means to complete the structure, and both must continue to do so.

There is another reason why it is important that this partnership should continue to flourish. We have in these islands over 50 million people who enjoy a material standard of living surpassed in few other countries in the world. Our mineral resources are limited and indeed declining. It is by means of the goods produced by manufacturing industry and the services provided by finance and commerce, in short by business as a whole, that our 50 millions are enabled to live, and on the whole to live tolerably well, in an area too small to feed them, at least by present methods.

All this is commonplace, but like much that is commonplace, it is easily taken for granted until we remember that over 90% of the world's population live in countries less prosperous than our own, most of them in conditions that we should not dream of tolerating. The world does not owe us a living; we can only enjoy the standards which our business enterprise and scientific knowledge enable us to earn through our exports. Like all countries whose livelihood depends on their export trade, we have a vested interest in economically and politically stable conditions throughout the world; and I mean stable, not static, conditions. Stability will not be achieved, for example, if plans for industrialisation of the less developed territories are obstructed from a misconceived notion that we may thereby be able to retain our own markets for that much longer. To those who heard Prof. Blackett's plea last year for technological aid to the underdeveloped countries, this may sound an unnecessarily narrow approach. But I have deliberately couched my argument in terms of expediency rather than moral compulsion, because it emphasises one respect in which the combination of science and business seems to me to be vital, and it is this: we must concentrate for our own survival on the development of new products and new processes.

Our old staple exports of textiles, iron and steel, and coal, have long since given way to newer lines: vehicles, aircraft, machinery, chemicals, and electrical goods. Even here the pattern keeps changing. Motor vehicles, fine and heavy chemicals, and so on, are increasingly being manufactured in countries which previously produced only food or primary raw materials. In India, I am told, a company manufacturing Diesel engines and electric motors is exporting 30% of its output. Chemicals from Red China and mass-produced toys and torches from Hong Kong are met in many of the world's markets. We are therefore obliged to rely either on selling things which no one else has yet learnt to make, or make as cheaply, or on marketing our skill and know-how.

It is not difficult to find examples of what happens to our business when "Rule of Thumbism" is preferred to operations guided and controlled by science and technology. I think there would be general agreement that at various times some of our traditional industries in which we were pioneers, have suffered from the lack of proper scientific direction.

In my own industry, organic chemicals

FIG. 3. **An Early Scientific Business Aid.** Lord Avebury using a dictaphone, 1902 (*Gernsheim Collection*). Lord Avebury (formerly Sir John Lubbock), F.R.S., was Vice-Chancellor of London University (1872–80) and later President (1881) of the British Association; he was M.P. for London Universities (1881). Study of the habits of ants and bees and of Primitive Man were his main fields of research.

once experienced the same neglect. The lead that Perkin had given to our synthetic dyestuffs industry with mauveine, was frittered away through lack of scientific effort. In the Presidential Address to the Chemical Society in 1915 his son, William Henry Perkin, Junior, referred to this neglect in these words: "My experience of the manufacturer in this country is that he is usually merely a commercial person who does not like the expert, and especially the idea of giving the expert a prominent position in the control of his works. Possibly the reason in many cases is ignorance of the value of science, but more probably it is due to the fact that being ignorant of science himself, he feels that if the expert is given too much prominence he must either study himself in order to understand the expert or leave the essential control of the business in his hands. Both these courses are distasteful to the ordinary commercial member of a board of directors; the expert is therefore relegated to the background, and the business comes to grief."

The lesson has not yet been fully learned, for even today we meet this attitude. I have a quotation here from a Managing Director which went on record last May. The scope of his company may be small and may be provincial, but that the sentiment still exists in minds capable of directorial control is significant. He writes: "The place of the expert is not in the saddle but as the assistant and the adviser. The scientist must be on tap, not on top." Such a relationship is very different from the partnership of science and business that I have in mind.

I have considered briefly some reasons why I regard the partnership of science and business as fundamental. To recapitulate, first it is because, if science is to carry forward our social evolution, it needs the financial and productive effort of business; and second, because the prosperity of this country depends on the technologically sophisticated products of our export trade.

A Balanced Partnership: How to Achieve it

The scientist in the business structure

I should now like to examine how this partnership can be achieved in practice, by considering the place of the scientist in the business structure. In a technological business we can distinguish some six or seven separate functions, depending to some extent on this definition: finance, commerce, personnel, operation or production, design and construction, research and development. I propose not to elaborate on these functions fully, but to touch on one or two of their features.

First, research: research has been called the life-blood of industry, but I prefer to liken it to the pituitary gland which, I am told, after doing little that is obvious for several years except consume nourishment, at length stimulates other parts of the organism to develop and makes it capable of production.

Research applied to business can take different forms, and I think you may be interested in one example within my experience. It began with a research manager's conviction that a new inhalant anaesthetic was needed which should have the following properties: it should be a volatile liquid, with high anaesthetic potency, and be free from toxic, explosive and fire hazards. These criteria, he argued, pointed the way to aliphatic halogen compounds containing little hydrogen and especially to compounds with two or three fluorine atoms on the same carbon atom—groupings which are known by organic chemists to be not only unreactive in themselves, but also to strengthen neighbouring carbon-halogen bonds. The resulting inertness is one of the factors in avoiding toxicity, and the use of fluorine rather than other halogens keeps the volatility high. He also proposed a new method of expressing dosages which made it possible to relate, by using a principle of chemical thermodynamics, the amount of anaesthetic in the inspired air to that in the body fluids. This helped in the selection, for biological testing, of compounds likely to have the desired potency, among which the one finally chosen was 2-bromo-2-chloro-1:1:1-trifluoroethane, a new compound synthesised specially for the purpose.

The major research effort, which for the first two years fell to the organic and physical chemists, had at this stage passed to the pharmacologists, whose screening tests took some three years. They showed that the new compound had not only the properties sought, including a high margin of safety from overdose, but also some unexpected advantages. Clinical trials with successful results began six years after the research started, and meanwhile manufacturing methods were developed by chemists and engineers, leading to general release to the medical profession two years later.

There are several features about this much abbreviated story, some of which are relevant to my present theme. It illustrates, first of all, the systematic application of pure scientific principles to a desired and well defined end which,

FIG. 4. **Modern Aids to Business.** A fleet of aircraft is maintained to assist the movement of senior Shell executives about Western Europe. This is the London-based fleet on the tarmac at Croydon Airport, comprising three de Havilland Herons, one de Havilland Dove, and one Miles Gemini.

(Shell photograph)

FIG. 5. **Research for Industry.** Two chemists in a research laboratory of ICI Plastics Division are, like many others, contributing to the increase of efficiency and high quality of industrial products in the office and in the home.
(ICI photograph)

though primarily commercial, is not without social implications. Second, the research threw light on the physicochemical basis of anaesthesia, which time, if no other reason, forbids me to enlarge upon. Third, success was crucially dependent on the existence of a team of specialists in several scientific disciplines and also in the somewhat recondite technology of fluorine; notwithstanding these favourable circumstances and adequate financial backing, the research and development took seven years. Fourth, the distinction between the research and the development function of business is brought out: the original synthetic and early testing work was research, while the development consisted of devising suitable methods of manufacturing and launching the chosen compound, and of studying its clinical effect.

I now turn to the functions of design and construction, which are essentially the field of the technologist or engineer. His grasp of scientific principles, combined with the creative skill of a Telford or a Fowler, fits him above all to build a bridge between science and business. It has been said: "The establishment of the class of engineers . . . is the more important because this class will, without doubt, constitute the direct and necessary instrument of coalition between men of science and industrialists, by which alone the new social order can commence." These words of Auguste Comte remain as fresh and as true today as when they were written over a hundred and thirty years ago.

The production or operation function includes the application of technical methods often according to a routine, though it also demands much planning and organisation. Although such work is sometimes considered humdrum and repetitive compared with research and development, it is often essential for it to be done by highly qualified technical men. It is just as great a mistake to believe that unqualified men who come up what used to be called "the hard way", are generally adequate, let alone best for production work, as to hold that good technical people are wasted in such jobs as plant management. On the contrary, they must be encouraged to regard it as an interesting and necessary part of their training for higher management.

If there are to be no weaknesses in any one part of the organisation, technical staff may have to be moved from one department to another, and this places a vital responsibility on those exercising the personnel function in selection, training, and promotion; at the same time it is their duty to ensure that employees can find satisfaction in their work. This function also can be conveniently performed by a scientist, whose knowledge of what the technical departments require, helps him to place staff to the best advantage both of the business and themselves.

On the commercial side also, scientists may be needed in sales, sales service or purchasing, to achieve the best results for a business making technically complex products. I cannot agree that employment of technical men in commercial departments is necessarily wasteful: it gives flexibility within the business, and can often ensure smoother co-operation when a works manager or research chemist feels that his own, the technical point of view, is understood by a man in one of the commercial departments; moreover, as training for higher administrative posts, commercial experience is invaluable to the scientist.

When he reaches such a post, the scientist, recognising the value of science in business administration, will be well placed to exploit it. I am not thinking here only of new equipment in the office, such as electronic computers or apparatus for sensing letters and figures; science has more to offer than mere tools. It offers the whole philosophy of the scientific approach to the problems of management. I need only remind you of some of the steps involved: definition of the problem, observation and collation of the relevant facts, formulation of a hypothesis or principle, its testing and its general application.

This approach has been of untold value in the examination of human activity and its measurement, which is usually described as work study. It has also been very successfully employed in the problems of supply and distribution, in adjustments of stock levels and in planning of delivery programmes. The full application of such methods usually involves some specialist techniques, especially of a mathematical kind, but even the first qualitative steps of the scientific

FIG. 6. **Brainpower for Manpower.** Perhaps the most mechanised office in the world is the Logexpo main office at the Brussels Central Station, filling in requests for room reservations at the Brussels Fair. IBM punch-cards, electric typewriters, sorting and accounting machines have taken the place of clerks.

(IBM photograph)

approach can often lead directly to improvements in business efficiency. All the same, it is worth noting that an otherwise successful application of such techniques can founder on the inability to handle human relationships with proper understanding.

Finance has played a conspicuous part in my address and, in my experience no technological business ever attempts to progress without continually seeking financial advice. However, I have failed to see in this country an equal acknowledgment that financial institutions need to take the benefit of continuing technological advice, though I am glad that some progress is being made in this direction overseas. For example, I know of a bank especially interested in natural resources which employs full-time geologists. Again, the World Bank orgnisation in Washington employs technical men not only at Headquarters, but also to carry out specific missions in various countries. Finance and technology will, I hope, become more and more interdependent as our businesses adapt themselves to current needs.

There is scope then for the scientist to infiltrate throughout almost the whole business structure. That being so, it is pertinent to ask, if scientists are to play an important part in business administration, is the balance between science and business likely to be upset? The answer to this question is, I think, threefold.

First, as British industry is at present constituted, the balance is heavily tilted the other way. That is to say, there are still many enterprises which are not employing qualified technical men even in tasks where one would expect to find them, and conversely there are no industries that appear to be harmfully dominated by scientists. This is due partly to the shortage of scientists and technologists with which we are all familiar, but partly also to historical circumstances. In the 19th century, due to this country's wealth of practical engineering experience, theoretical knowledge was undervalued. At the same time, an educational bias towards the classics, based on an aristocratic tradition, sometimes led the second and third generation of a manufacturer's family to forsake the business altogether for politics or the bar, or if not, at least to be quite unfamiliar with the value of science. Again, as we have seen, in some concerns scientists are relegated to the position of advisers to management and are allowed little part in the active control of the business.

Second, in businesses where scientists rightly play a prominent part in administration, non-technical men who nevertheless have a good understanding of scientific principles, are with advantage sometimes put into semi-technical jobs, and this helps to maintain a balanced partnership.

Third, and most important, the balance that we seek must come in great measure from within the individual himself, a balance provided by the education which the scientist and the non-scientist ought to receive. This, besides being central to my theme, is very much the personal concern of many of us here.

Balance in Education

There are three senses in which we might consider balance in education. The first arises from two different conceptions of the purpose of education. On the one hand there is the formation of character, and the development of intellect and personality. At the other extreme is the concept which I suppose finds its most powerful expression in the educational philosophy of Soviet Russia, that the purpose of education is to provide useful members of society in which the desires of the individual must be subordinated to the needs of society.

I do not believe that these two concepts are wholly conflicting nor that the second runs completely counter to the British tradition of individual liberty. A balanced educational system should have room for both. The striking successes achieved by the Russians in science and technology are directly attributable to a system of education deliberately designed to produce large numbers of technically trained men and women with the ability to increase the economic power of the country through industrialisation. To this end they established a strong teaching profession to which recruitment is no problem because it enjoys the highest pay and status of all the professions. Though undoubtedly State direction still has a place in the Russian educational system, its purpose is being achieved to an increasing extent by incentives.

We are proud that our Universities, despite their growing financial dependence on the State, still retain their academic independence intact. Nevertheless, they have quite properly reacted to the stimulus of the country's needs which have led the older Universities, for so long the home of the humanities, themselves to enlarge their science faculties. The new St Catherine's College at Oxford and Churchill College at Cambridge will give particular prominence to the study of science. The introduction of transfer scholarships to enable promising arts men to turn to science, has been readily accepted. More sixth-formers are reading science in the Public and Grammar Schools. Some long-term financial incentives may operate here, but more important has been an intensive propaganda effort which I hope will be sustained by this Association's programme for organising lectures up and down the country on the lines of those so successfully pioneered by the Royal Institution in London.

So, in framing our formal education, we cannot entirely ignore the requirements of the society on whose prosperity depend the very conditions in which our educational system can progress; but our society will not be tolerable to live in, if its members are not permitted to develop their personalities and talents.

This brings me to the second sense in which I refer to balance in education. I am thinking here of the need for those who study the humanities to have some understanding of the workings of science and for our scientists to widen their horizons by relating their science to its human context both historically and in terms of the present day. I have in the past on several occasions declared my belief that the gulf which at present separates our scientists and non-scientists, is much more easily bridged than is often imagined. For example, the qualities of mind which are fostered by studying chemistry and history are very much alike. Both chemists and historians must cultivate an inquisitive and acquisitive mind. Both need to exercise judgment, leavened with a good measure of scepticism in the exemplary tradition of Robert Boyle. Both must be imaginative, the chemist in advancing hypotheses to predict the future, the historian in doing so to explain the past.

The merits of a balanced curriculum are recognised in Soviet Russia, where children between 11 and 17 devote something like 46% of their working hours to science subjects, with the emphasis predominantly on mathematics, and another 46% to what we could call arts subjects, with the emphasis here on Russian language and literature. Clearly a correct balance can never be achieved with premature specialisation, which the current demands for entry into many Universities impose on our most talented students.

There is a third and final sense in which I refer to balance in education. I have said that we demand, from our scientists and non-scientists alike, intellectual qualities, such as curiosity, judgment and imagination. Equally we want our young people, whatever their branch of study, to possess high qualities of character. I need not enlarge on this theme except to say that the society which a balanced partnership of science and business can help to build, will as always call for courage, integrity and tenacity. These are some of the ideals that we might have in our minds, as we each address ourselves to the problems of education for an age of science.

Conclusion

My theme, has been broad and general. It does not call for revolutionary action; it calls rather for sustained progress, and, of the two, that is sometimes the harder to inspire.

I have tried to show why science and business must be partners: the advancement of science can only be achieved with the resources which business can provide and, if business is to provide them, then it must bring science to its aid. I have also suggested that a truly balanced partnership will manifest itself in the growing use of science and its methods in business; and that it can only come from a balanced education for scientists and businessmen alike.

I believe this balance to be important for our well-being, and as we inaugurate this 120th Meeting of the British Association, we can take with sincerity and all humility for our own work, the objective for his college expressed in Anderson's will:

"For the good of mankind and the improvement of science."

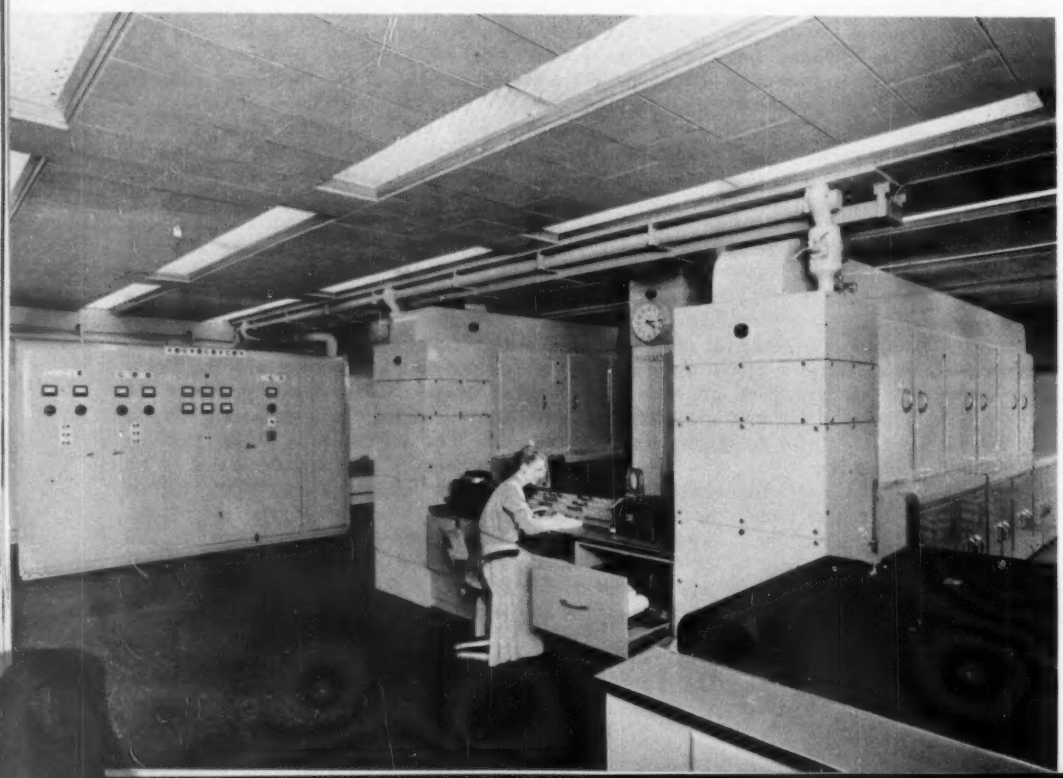


FIG. 7. **The Future.** One of the largest electronic computers in Western Europe is "Miracle", used for fundamental and technical research at the Amsterdam laboratory of the Royal Dutch/Shell Group. It was built by Ferranti Ltd, Manchester, and cost nearly £150,000. "Mercury", an even larger business computer, will be used by the Shell Company for market research work, business calculations, and market forecasts.

(Shell photograph)

THE SENSORY EFFECTS OF ESSENTIAL OILS

DR EMIL VON SKRAMLIK

Director of the Institute of Physiology, Humboldt University, Berlin

The term "essential oils" is somewhat misleading, for one might think it applied to oily substances, whereas it actually applies chiefly to terpenes and refers to substances or mixtures which can be extracted from parts of plants such as buds, leaves, roots, and fruit-rinds. There are various ways of extracting terpenes; lemon-peels are pressed, for example, whereas rose- and lavender-petals are minced and then distilled.

The composition of essential oils varies according to their origin, and any one substance can generally be found in different oils. *Pinene* (odour of pine) and *linaloöl* (odour of roses) are both to be found in coriander oil, although each may also be extracted from other sources. The same plants yield essential oils which vary in composition according to the part of the world in which the plant grows. Thus, pine oil contains very different ingredients according to whether it comes from Germany or from Siberia.

Essential oils are the raw materials from which perfumes are made. The substances extracted from plants or parts of plants are generally fragrant, but there are some exceptions, such as mustard oil, which provokes extremely unpleasant sensations.

These oils are also very important in pharmacy. Therapeutic effects vary according to the nature of the oil and the way it is used. The oils are generally taken orally but can also be applied to the skin, or may be inhaled. The field of application for essential oils is therefore very wide. This has been proved by recent attempts to use them for the domestic disinfection of air, which has made it necessary to test their bactericidal powers. The results, so far, are not very conclusive, but it has been demonstrated that it is possible to achieve bacteriostatic or even bactericidal effects with the help of essential oils, or rather with the pure substances they contain.

It might be of interest to indicate the chemical nature of a certain number of substances contained in essential oils. Table I gives the most important representatives of different chemical groups, and shows the great variety of the chemical constitution of essential oils. The substances, however, vary little in their molecular weight.

TABLE I

Pure olfactive substances of various groups, contained in essential oils. The molecular weights of these substances vary only a little.

No.	*Trade-name*	*Chemical designation*	*Formula*	*Molecular weight:*
1	Pinene	2,6,6-Trimethyl-bicyclo-(1,1,3)-hept-(2)-ene	$C_{10}H_{16}$	136
2	Geraniol	3,7,-Dimethyl-2,6-octadien-1-ol	$C_{10}H_{18}O$	154
3	α-Terpineol	1-p-Menthen-8-ol	$C_{10}H_{18}O$	154
4	Eugenol	4-Allyl-guaiacol	$C_{10}H_{12}O_2$	164
5	Citral	3,7-Dimethyl-2,6-octadien-1-ol	$C_{10}H_{16}O$	152
6	Methone	1-Methyl-4-iso-propyl-cyclo-hexan-3-one	$C_{10}H_{18}O$	154
7	p-Cineol (Eucalyptol)	1,8-epoxy-p-menthane	$C_{10}H_{18}O$	154

Although much attention has been given to the extraction of essential oils and to their composition, their sensory effects have received little consideration, and apart from the obvious question of odour, their secondary effects have been neglected. The necessary studies, however, are not easy to carry out because the effects of essential oils on the human organism are very complicated, so complicated in fact that it is almost impossible to describe them. It is difficult enough to describe simple sensations adequately, but it becomes many times more difficult with complex or collective sensations, and essential oils not only excite the senses of smell and taste, but also activate many other organs of the senses.

The existing descriptions of the sensory effects of essential oils are insufficient and often erroneous, as many effects are wrongly attributed to sense-organs which are not affected. The aim of the experiments described here, therefore, is to analyse the sensory effects of essential oils. For this purpose a selection had to be made as there are more than 150 essential oils. The effect on the senses of twenty-six types have been examined, namely, those registered in the seventh edition of the "Deutsches Apothekerbuch" ("German Pharmaceutical Codex"): angelica root, aniseed, valerian, bergamot, Ceylon-cinnamon, eucalyptus, fennel, calamus, peppermint, rose, rosemary, sage, mustard, turpentine, thyme, juniper berry, citronella, and lemon oil. Most of these essential oils are for internal use, and only relatively few are to be used externally. Some of them can be used both internally and externally, while others, such as pine-needle oil, are best used as inhalants.

PERSONAL RESEARCHES

In order to obtain an exact analysis, the sensory effects of essential oils had to be examined (1) when they were inhaled through the nasal cavity (we shall not discuss here the remote effects the inhalation of essential oils produce by irritating the mucous membranes in the deeper parts of the respiratory system), (2) when introduced into the oral cavity, and (3) when applied to the skin. It was found that several sense-organs were affected in addition to the one uniquely associated with the area of application. Thus, when one smells an essential oil, not only is the sense of smell activated, but also the sense of taste, and the organs which perceive pressure, warmth, cold, and pain at the entrance of the nose.

Similarly, the introduction of an essential oil into the oral cavity activates several sense-organs besides that of taste, in particular those of pressure and pain and sometimes those which perceive temperature. Also, an effect on olfaction can be produced through the choanae. We know from experience that the sense of smell can be excited not only by inhalation but also by exhalation when the air is pushed through the choanae to the entrance of the nose. This also happens when particles of odorous substances happen to be in the buccal cavity.

When an essential oil is applied to the skin, different sensations are experienced depending on the organs of perception in the area concerned. It may happen that in one area the perception of temperature and in another the perception of pain is especially affected, for as we know areas of insensitivity exist on the skin and on the mucous membranes. It is therefore advisable to classify the sensual-physiological characteristics of essential oils according to the organs they affect.

In the experiments the first task was to determine the threshold of perception for different sensations; that is, the degree of irritation necessary for producing a sensation, of a general or of a particular nature. The senses of taste and of smell both have general and specific thresholds. In the first case one can distinguish a completely odourless or tasteless substance without being able to identify the oil as such; in the second case, although some experience will be necessary, it is possible to recognise and name the substance. Knowledge of the threshold levels will make it possible to compare the oils in their effects on the organ concerned. The lower the threshold level the stronger the sensual effect.

In trying to find the threshold levels of essential oils, peculiar difficulties arose from the fact that the oils are scarcely soluble in water, a medium which lacks smell and taste. In order to dissolve them, highly concentrated alcohol (80% and more) must be used. Now, alcohol is a medium which itself possesses smell and taste, and easily provokes a sensation of burning, warmth, and pain. Obviously, then, alcohol could not be used as a solvent in investigating this problem.

As it is difficult to find an odourless, tasteless solvent for esential oils, some other means had to be found. Thus, one drop* was put into a certain amount of water and the mixture shaken until the drop was finely subdivided as judged by visual observation. A drop from this dilution was treated in the same manner, and so on until the limit of sensory perception had been reached. It is most important to shake the mixture each time very thoroughly, as it is bound to separate again if it stands for some time. After the limit of sensory perception has been reached, further degrees of dilution have no more effect. The shaking has the advantage of preventing large quantities of essential oils from sticking to the inside of the glass. It is true that this can never be entirely avoided but the losses that occur by proceeding in this manner are so small that they can be ignored. Our own tests have shown that the activity of essential oils is not influenced by this method, which is approximately equivalent to diluting it in water.

In order to discover the threshold of smell a simple odorimeter is used: 10 ml. of the concentration concerned are put into a Petri dish of 6·8 cm. internal diameter; the surface of evaporation of 36·5 sq. cm. is therefore the same in all cases. If we smell the thoroughly shaken mixture immediately with the nostrils held only just above the surface of the liquid, we shall be able to state whether there is an odour, or not. If the difference between the concentrations having odour and no odour is not very great, the average between them will indicate the threshold.

* The number of drops per 1 g. varies considerably according to the oil concerned (between 37 and 58 for the oils which were examined).

To find the threshold of taste of essential oils, 10 ml. of the mixture, suitably diluted, are introduced into the mouth and kept there a certain time to allow a methodical examination. In order to find the threshold of the sense of touch, pieces of filter paper of 2 cm. diameter, soaked in a suitable dilution, are applied to the skin and left there for a time to see whether there is any effect.

EFFECT ON THE NASAL CAVITY

Table II shows the sensory effects of seven essential oils when they are mixed with air and inhaled through the nose. These effects vary with the different kinds of essential oils, and from the values of the threshold degrees we can ascertain the intensity of the effects.

TABLE II

The sensory effects of essential oils in the nose. The threshold concentration on which the effect produces itself is indicated in per cent.

Oil	*Subject*	*Smell*		*Sense of Cold*	*Sense of Pain*
		General Threshold	*Specific Threshold*		
Angelica	1	0·00022	0·0020	—	—
Anise	1	0·00024	0·0024	—	—
Eucalyptus	1	0·00037	0·0023	0·19	—
Fennel	1	0·00023	0·0025	—	—
Peppermint	1	0·00011	0·0012	0·10	—
Rose	1	0·00002	0·0002	—	—
Mustard	1	0·00017	0·0010	—	0·01

All essential oils, including those not especially mentioned in the table, have their own special smell by which they can be recognised, though sometimes with difficulty (citronella oil, for instance, reminds us very strongly of lemon oil). With some experience, however, it may be possible to differentiate between these two kinds of oil. As far as can be judged from the threshold levels, attar of roses has the strongest smell and mustard oil the faintest. The general threshold for the former is 0·00002%, for the latter 0·00017%. The specific thresholds are much higher. In the case of attar of roses the concentration must be increased ten times if we are to ascertain that it is veritably attar of roses.

The degrees are given in per cent and not molecularly because the composition of the oils is not sufficiently known. The threshold levels are much higher for oils than for pure substances. This is not at all surprising because the concentration of pure olfactive substances they contain is relatively small.

In addition to affecting the sense of smell, some of the oils, such as peppermint and eucalyptus, excite the sense of cold as well. But the thresholds for the sense of cold lie much higher than those for smell, often 1000 times higher. Mustard oil affects the sense of pain. A feeble concentration (0·01%) causes a light pricking. But the most unpleasant effects can be produced by increasing the concentration. Smelling this oil produces extremely unpleasant sensations in the occipital regions of the head, and also in the forehead.

It should be noted that it is not especially difficult to detect the thresholds for the various organs of sense, as their levels are very different. The various degrees are, of course, to be considered as relative and not as absolute.

They therefore count only in comparison with the degrees for other oils. Owing to the nature of the research, they are subject to errors of at least ±20%.

ESSENTIAL OILS IN THE MOUTH

Table III indicates the sensory effects which the same essential oils provoke when 10 ml. of the solution, after being diluted and shaken up with water, are introduced into the mouth. The threshold levels for smell mentioned

TABLE III

The sensory effects of essential oils in the mouth. The threshold concentration at which the effect produces itself is indicated in per cent.

Oil	*Subject*	*Sense of Smell*		*Sense of Taste*			*Sense of Cold*	*Sense of Pain*
		General Threshold	*Specific Threshold*	*General Threshold*	*Specific Threshold*			
					bitter	*sweet*		
Angelica	1	0·0002	0·001	0·040	0·100	—	—	0·07
Anise	1	0·0002	0·002	0·001	0·095	0·004	—	100
Eucalyptus	1	0·0003	0·002	0·012	0·025	—	0·02	0·19
Fennel	1	0·0002	0·002	0·002	—	0·005	—	100
Peppermint	1	0·0001	0·001	0·004	0·004	—	0·002	0·039
Rose	1	0·00002	0·0001	0·005	0·006	—	—	0·04
Mustard	1	0·0001	0·001	0·006	—	0·007	—	0·001

here concern the olfactory effect produced by expiration from the mouth by way of the choanae. It is interesting to note that the ratio of the general to the specific thresholds for smell (Tables II and III) is approximately constant. The distances which the particles have to cover before reaching the epithelium of olfaction is obviously about the same whichever route they take, whether from the entrance of the nose *or* from the mouth by way of the choanae. The surface of evaporation will be approximately the same from the Petri dish as from the buccal cavity.

The threshold of taste of essential oils lie on a relatively high level. With pepperment oil, the concentration for the sense of taste has to be 40 times as strong as that for the olfactive sense; for attar of roses, 250 times as strong, and for mustard oil, 60 times as strong as for the corresponding threshold of olfaction. On increasing the concentration which corresponds to the general threshold, there is a pronounced effect on taste (specific threshold). Many oils taste bitter, some of them sweet. Anise oil, in a solution of 0·004, tastes sweet. By increasing the concentration to about 25 times its strength, the taste will become bitter

Peppermint and eucalyptus oil produce a sense of cold. But these oils influence the sense of taste in a concentration much lower than that which acts upon the nasal cavities. Several essential oils, especially mustard oil, attar of roses, and peppermint oil, affect the sense of pain in the mouth. Pain is specially provoked by undiluted oil. As a rule, the effect of cold and pain is more easily perceived in the mouth than in the nose.

On reaching the specific threshold we can indicate the effects of essential oils on the sense of taste and consequently say whether they taste bitter or sweet. Other qualities of taste have not been noted. An appreciation of the taste of essential oils with respect to quality and quantity can best be established by taste equations (Tables III and IV). However, great difficulties arise in this kind of research, partly because the secondary effects are often so strong that it is impossible to separate these sensations from the effect of taste.

The analytic equations for the seven essential oils referred to are to be found in Table IV. They vary a great deal individually. For instance the taste of a mixture of anise oil at 0·01% corresponds, in one case, to a solution of glucose at 0·105 Molar and in another to one at 0·90 Molar. There was little difficulty in establishing the equations for peppermint oil and attar of roses, as these two oils possess a purely bitter taste. Their thresholds of pain lie on a much higher level than their thresholds of

TABLE IV

The analytic equations of the various essential oils, established with two dilutions (a–b). The concentration of the essential oils is indicated in per cent, the substances of taste (Chinin-hydrochloricum [Ch.h.], common salt, hydrochloric acid and dextrose) are indicated in molecular concentration. rt—resembling in taste.

Oil	*Subject*		*per cent*	*Ch.h.*	*NaCl*	*HCl*	*Dextrose*
Angelica	a	1	0·200 rt	0·000014	0·0010	—	—
	b	1	0·100 rt	0·000007	0·0005	—	—
Anise	a	1	0·010 rt	—	—	—	0·106
	b	1	0·005 rt	—	—	—	0·090
Eucalyptus	a	1	0·190 rt	0·000069	—	—	—
	b	1	0·037 rt	0·000010	—	—	—
Fennel	a	1	0·015 rt	—	—	—	0·088
	b	1	0·009 rt	—	—	—	0·066
Peppermint	a	1	0·019 rt	0·000050	—	—	—
	b	1	0·009 rt	0·000033	—	—	—
Rose	a	1	0·018 rt	0·000044	—	—	—
	b	1	0·007 rt	0·000028	—	—	—
Mustard	a	1	0·013 rt	—	—	—	0·108
	b	1	0·008 rt	—	—	—	0·066

taste so that the research for the analytic equations was easier than in the case of mustard oil.

EFFECTS ON THE SKIN

The oils applied to the skin usually provoke a pleasant sensation of warmth. In any case it is easy to distinguish a piece of filter paper soaked in essential oil from another one soaked in water; it does not matter whether they are applied alternately on the same part of the body or at the same time on two symmetrical parts. Some oils provoke a burning on the skin. A sensation of cold is sometimes felt after applying peppermint and eucalyptus oil. The strongest effect is caused by mustard oil which provokes a burning sensation even if used in a weak concentration. We must stress the fact that in the course of these experiments different areas of the skin reacted differently. Pain can be caused much more easily on the immediate surrounding of the orifices of the body (ears, eyes, nose, and mouth) than on other parts of the skin. The epithelium of the surface of these parts is without doubt particularly sensitive.

SIDE EFFECTS

To the sensory effects of essential oils must be added the side effects and the general (affective) psychological response which they also provoke. Side effects have to be considered when essential oils such as mustard oil, cause an inflammation of the conjunctiva of the eye or of the mucous membranes of the respiratory system. The remote

side effects of these oils must also be considered (again, as in the case of mustard oil) when they cause very painful sensations in the occipital regions of the head after being transmitted through the trigeminal nerve.

As in the great majority of cases essential oils are taken orally, it is desirable from the psychological point of view to know if they have a pleasant or an unpleasant taste and in particular if they provoke aversion or even nausea. Of the 26 essential oils referred to, the following are typically unpleasant when taken orally, even in a feeble concentration: angelica root, Ceylon cinnamon, calamus, cassia, caraway seed, clove, parsley seed, rosemary, sage, mustard, thyme, and citronella oil. Camomile, lavendar, attar of roses, and lemon oil are neither pleasant nor unpleasant. The others provoke a pleasant sensation in the mouth if taken orally in not too strong a concentration.

SUMMARY

This account shows that there is a vast amount of research still to be done on the physiological effects of essential oils, but above all, on their sensory effects. Only 26 of the 150 existing essential oils have been examined for this purpose, and these evaluations have allowed us to obtain some insight into their working. As far as it is possible to say at the moment, all essential oils have an effect on the sense of smell although in an extremely varying degree. A very strong effect on the sense of smell was produced by Ceylon cinnamon oil, calamus oil, and mustard oil, but attar of roses had the strongest effect; the feeblest effect was noted with pine oil, thyme oil, and turpentine oil.

The effect of most of the essential oils on taste is limited to the sensations of bitterness or sweetness, as may be seen in Table III. In valerian oil we may find a slight sour compound, due to the presence of valerianic acid. A salty taste has never been detected in any oil. An effect on the sense of cold is relatively rare, but is distinctly perceptible with eucalyptus and peppermint oil and hardly perceptible with rosemary oil. Most essential oils produce a sensation of warmth on the skin or the mucous membranes. Although one might intercept this as an influence on the sense of warmth, it may be a phenomenon related to protection against the loss of warmth. Under the influence of essential oils the sense of warmth often enhances the sense of pain to produce a sensation of burning. However, the sense of pain alone can also be activated by many essential oils in varying degrees under various forms.

As these statements prove, there has been some progress in the appreciation of sensory effects of essential oils. We are, however, still far from our aim, which is to ascertain their qualitative and quantitative effects. Consequently, not only the essential oils themselves, but also the pure olfactive substances they contain will have to be analysed. The chief aim will be to advance our knowledge of the effects of essential oils in order that we may increase the components acting pleasantly on the senses, and suppress the unpleasant ones. Thus, it will become possible to enlarge the field of their use for the benefit of mankind.

READING LIST

1. Kellner, W. und Kober, W., 1956, *Arzneimittelforschung*, vol. 6, p. 768.
2. v. Skramlik, E., *Pharmazie*, 1956, vol. 11, p. 749.
3. Vetterlein, S., "Die sinnlichen Wirkungen der ätherischen Öle in den Nasenhöhlen", *Med. Inaug. Diss.*, Berlin, 1956.
4. v. Chamier, S., "Die Wirkungen der ätherischer Öle in der Mundhöle", *Med. Inaug. Diss.*, Berlin, 1956.
5. Priebe, W., "Die Geschmackswirkung ätherischer Öle in der Mundhöle", *Med. Inaug. Diss.*, Berlin, 1956.
6. v. Skramlik, E., 1921, *Z. f. Sinnesphysiol*, vol. 53, pp. 36, 219.
7. ——, "Handbuch der Physiologie der niederen Sinne", Leipzig, 1926.

EIGHTY-EIGHT YEARS AGO

CAPTAIN NEMO AND COMMANDER W. R. ANDERSON, U.S.N.

Tout ce qu'un homme est capable d'imaginer, d'autres hommes seront capables de le réaliser. Never before have these often quoted words of Jules Verne been better illustrated, than when U.S.S. *Nautilus* passed below the North Pole at 03.15 G.M.T. on August 4. It was Jules Verne himself who described in his classical "20,000 Leagues Under the Sea", published in 1870, how Captain Nemo navigated his *Nautilus* in South Polar Seas.

He passed below the pack-ice at a depth of 2400 ft. and at a speed of 26 knots, he reached some land at the South Pole. There Captain Nemo planted his black standard on top of a thousand-foot mountain and took possession in his own name of the Antarctic Continent. On the return journey north disaster nearly brought the explorations of the submarine to an end. Again crossing below the pack-ice, an iceberg suddenly overturned and shut the *Nautilus* in a tunnel of submarine ice through which no exit could be found. However, the crew in Rouquayrol self-contained diving suits (the actual forerunner of the present-day frogman's suit) removed a slab of ice 30 ft. thick below the submarine through which the Nautilus just managed to escape.

In contrast to this futuristic tale of 88 years ago the passage of U.S.S. *Nautilus*, Commander William R. Anderson, U.S.N., below the North Pole appears to have been a straightforward piece of modern efficiency. Careful meaurements of the ice thickness above were carried out throughout the voyage, and a detailed profile was traced. From this profile it appears likely that the estimate of the quantity of ice in the Arctic will have to be raised considerably. Navigation was carried out by means of an "Inertial Navigator", a piece of equipment developed originally for guided missiles and rockets.

This historic voyage will rank high among the annals of exploration, and the scientific, economic, and technical possibilities which are now opening out will undoubtedly bring new benefits to mankind. Indeed "what one man is able to imagine others are capable of realising".

(A brief explanation of Inertial Guidance will appear in Mr R. Hadekel's article, "Automatic Flight Control", in the October issue of DISCOVERY*; and a full article, "Trans-Polar Flights" by the Vice-President of the Scandinavian Airline system, discussing the navigation of aircraft over the North Pole will appear in one of the future issues of* DISCOVERY.)

MAUVOISIN—THE HIGHEST ARCH DAM IN THE WORLD

H. R. FIECHTER

Association des Entrepreneurs du Barrage de Mauvoisin

Switzerland has always been notable for the ingenuity and skill applied to the harnessing of its sole natural resource in the field of energy production—the capturing of the power of falling water. In most countries, the authorities concerned with the development of hydro-electric power must of necessity seek for the cheapest method of providing the dams and other civil engineering structures required to build up a head of water. The majority of these projects, wherever possible, employ earth or rock fill dams, with the arch type of dam, generally very much more costly, used only where no other solution can be applied.

The construction of any type of thin arch dam requires the deployment of the highest levels of civil engineering skill; the joint between the dam itself and the walls of the valley which it closes involves a great deal of exploratory work into the nature of the rock, its underlying soundness, and above all into the water-tightness of the rock or ground below and around the dam. In spite of all this work, and of the calculations undertaken as a result, it is still necessary to apply judgment and experience, since it can never be quite certain that the characteristics of the terrain are fully known. Thus the building of a dam 777 ft. high—over two-thirds the height of the Eiffel Tower—and 1700 ft. long at the crest, must of necessity be regarded as a civil engineering feat of the highest order.

Such a project was completed at Mauvoisin in the southwestern part of the Swiss Alps at the end of last year, and the two power stations associated with the project are now in operation.

The Mauvoisin project was designed to harness the water of the Dranse de Bagnes. This river has its source 7300 ft. above sea-level at the foot of the Otemma glacier, and, after a course of 28 miles, descends to a level of 1470 ft. At the end of its course it joins the River Rhône. The Mauvoisin Lake extends for 3 miles behind the Mauvoisin dam.

This large storage-reservoir has a surface area of 51 acres, and a capacity of 235 million cu. yds of water, which is accumulated from the catchment area of 73 sq. miles, of which 30 sq. miles is glacial terrain.

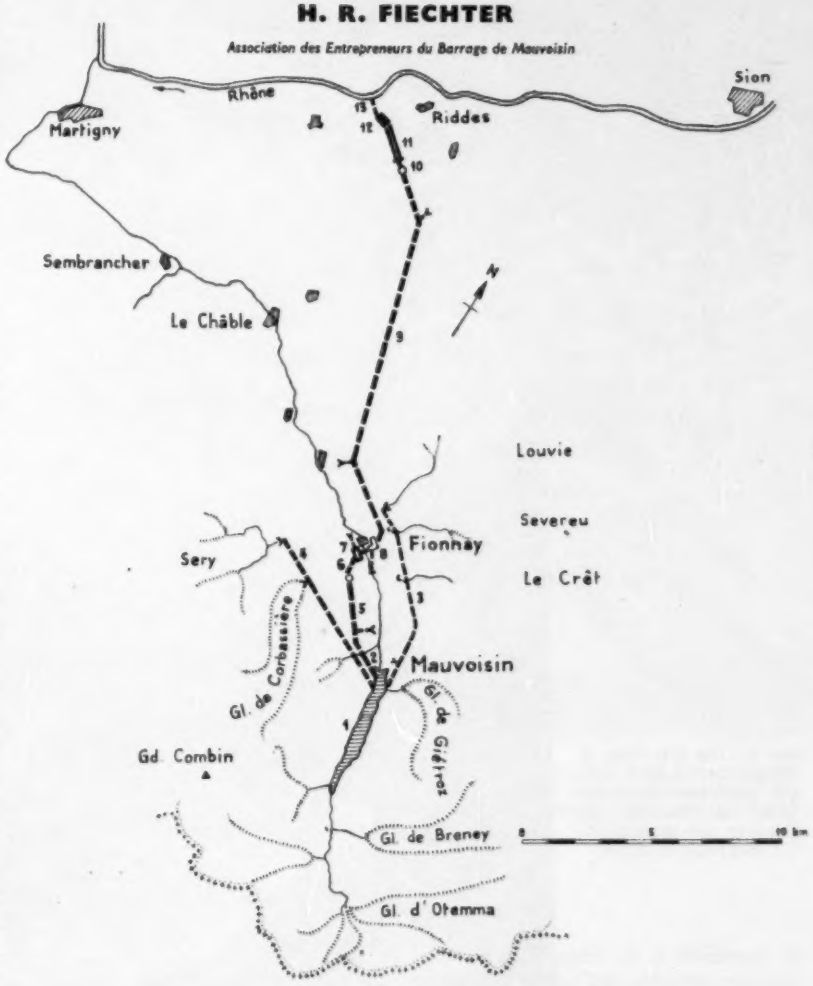
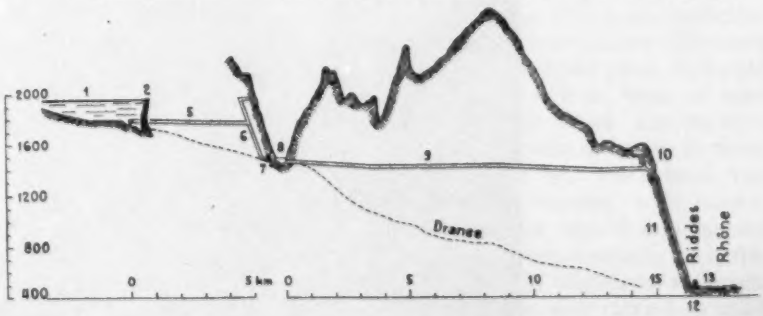


FIG. 1. The Mauvoisin Scheme.
(1) Lake. (2) Arch dam. (3 and 4) Pipe conducting water from Louvie, Sévereu, Le Crêt, Sery, and the Corbassière glacier to the reservoir. (5) Pressure tunnel between Mauvoisin and Fionnay. (6) Surge chamber at Fionnay. (7) Fionnay power house. (8) Compensation basin at Fionnay. (9) Pressure tunnel between Fionnay and Isérables. (10) Surge chamber at Villy. (11) Penstocks between Isérables and Riddes. (12) Power house at Riddes. (13) Underground tail race.



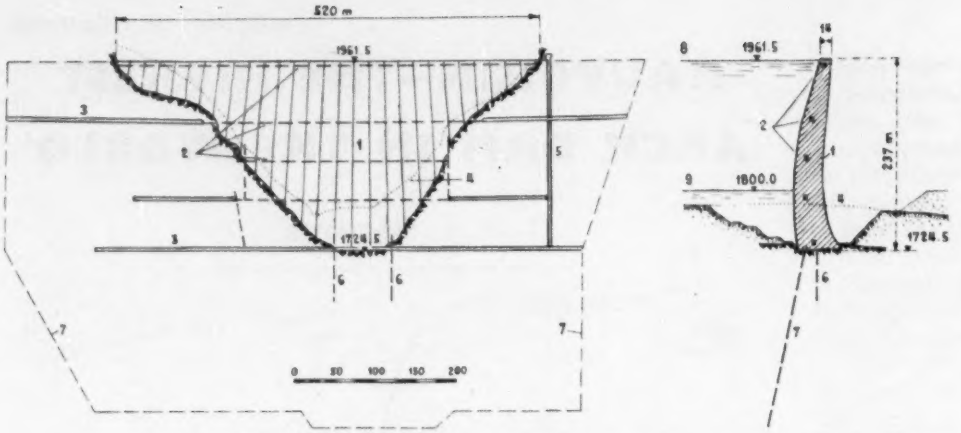


FIG. 2. The Mauvoisin Dam. (1 and 3) Injection galleries for sealing works. (4) Natural ground. (5) Lift. (6) Pendulum shaft. (7) Injection zone (zone of sealing works). (8) Maximum level of the lake (1961·5 m. or 6435 ft.). (9) Minimum level of the lake (1800 m. or 5905 ft.).

FIG. 3. The first stage in the scheme. (1) Arch dam. (2) Underground power house at Fionnay. (3) Outdoor sub-station. (4) Compensation basin.

FIG. 4. Fionnay. (1) Compensation basin. (2) Outdoor sub-station. (3) Control building. (4) Additional water-intake.

TESTS AND RESEARCH

The project was first considered in 1948–9, and in 1950 a provisional decision was made to choose the Mauvoisin site to close the valley. A considerable programme of geological research was then undertaken, using electrical methods to determine the nature of the ground by measuring variations in conductivity between one point and another, and by seismic measurements. Test bores were made, and the subsoil was investigated to a depth of 660 ft.

These research programmes and tests indicated that the rock underlying the site of the projected dam was covered by about 130 ft. of gravel and sand deposited by the river. The rock was found to be compact in nature, but not impermeable. The latter discovery meant that at a later stage a very extensive programme of grouting to seal off the area round the dam had to be undertaken.

The civil engineer, confronted with a project of this magnitude, has to make the difficult decision as to what effect the weight of the impounded water and of the dam itself will have on the underlying rock, possibly causing it to deform and thus to exercise a deforming influence on the dam itself. He must also take account of the forces set up by temperature variations, by possible earth tremors, and by the deformation of the flanks of the valley caused by the filling-up of the lake.

It was finally estimated, in the case of the Mauvoisin project, that the compressive force on the foundations, resulting from all the factors mentioned above, would be of the order of about 1280 lb. per square inch. The Swiss authorities concerned with the safety of public works prescribed a safety factor of about 4, and thus it was necessary to produce a type of concrete which would have a compressive strength of 5400 lb. to the square inch, this figure referring to measurements taken on test cubes of 1 ft. side, after ageing for 90 days.

The dam is 175 ft. thick at the bottom and tapers to a thickness of 46 ft. at the top. The concrete required for its construction reached the enormous total of 2,635,000 cu. yds.

As is customary with structures of this type, the dam was subdivided into sections, 28 in this case. The work proceeded by pouring concrete in alternate sections, so that at any particular stage of construction the top of the dam presented a castellated effect, the height of the higher sections being at least 10 ft. above the others, and the concrete being allowed to set for 36 hours before the next "lift" was poured. The concrete was vibrated with electric "needles" which were 3 ft. long and 5 in. in diameter, operating at a frequency of 7300 vibrations a minute. These machines were carried on small

FIG. 5. (*Left*) Mauvoisin. (1) Concrete-making tower and cement silo. (2) Living-quarters for workmen. (3) Bank of material. (4) Gravel- and sand-preparing plant. (5) Diversion channel.

bulldozers on the top of the dam, and every cubic yard of concrete, on the average, was vibrated for 2½ minutes. This process ensures sound and uniform concrete, and removes excess water.

REFRIGERATING THE CONCRETE

Among the problems encountered by civil engineers on this type of construction is that of dispersing the natural heat generated by the setting of the concrete. This amounts to about 160 B.Th.U. for every pound of cement. The mass of concrete could reach a temperature of up to 104°F after three days of settling, and, to avoid any possibility of uneven shrinkage due to thermal effects, is was desirable to cool the concrete artificially. After every lift of 10 ft. the concrete was covered with a network of ¾-in. cooling pipes, through which water was circulated to enable the heat to be evacuated. In spite of this refrigeration process, it was inevitable that small cracks, of the order of ⅛ in. wide, should appear at the joints between sections and lifts, and this necessitated the usual grouting procedure.

FORMING A WATERTIGHT SCREEN

As mentioned above, the rock and ground at the sides of the dam and below its foundations was found to be not entirely watertight. This is usually the case on projects of this type, and the method adopted to prevent leakage of water (which is not only undesirable for the obvious reason, but may also eventually undermine part of the load-bearing foundations) is to drill bore-holes and small galleries into the appropriate areas and then to fill them with a mixture of cement and water, or other suitable grouting mixture, under pressure. This mixture, which ultimately sets and forms a watertight screen, spreads into all the cracks and fissures in the rock, and thus it is essential that the bore-holes should interlace so that no possible leakage path is neglected. In the case of the Mauvoisin project, the total length of the bore-holes needed for the injection grouting was no less than 37 miles, with the addition of 1100 yds of galleries made for injection purposes. The depth of the mask extended to 720 ft. below the bottom of the dam.

FIG. 6. (*Above*) One of the Mauvoisin explosions. The conventional excavation methods consisting of regular small blastings were found in this case to be inadequate and dangerous. Therefore, a series of 3½-in. holes were drilled parallel to the rock surfaces and filled with 44,000 lb. of explosives. The simultaneous blasting of 90,000 cu. yds of rock caused lorries and excavators to work for three weeks to clear away the debris.

The water from the dam is taken to the first power station at Fionnay. The pressure tunnel, which brings in the water, is itself a remarkable feat of engineering It is 5200 yds long, with an inside diameter of 10 ft. It would be usual to employ, for this part of a hydro-electric project, either a strongly reinforced concrete pipe-line, or else a steel penstock. It was, however, decided to investigate the possibility of arranging for the enormous water pressure to be carried in a tunnel cut in the rock and not specially lined or reinforced. After an intensive programme of tests and studies, it was decided that a pressure intake gallery could be constructed in the bare rock. This is the first time such a structure has been designed for a head of over 600 ft. The rock was lined with a concrete ring 10 in. thick and the upper part was reinforced. The falls of the intake were grouted under high and low pressure to seal off any possible leakages.

In the majority of hydro-electric schemes, it is necessary to provide some form of relief for the water if a sudden emergency necessitates the closing of the valves (or gates, as they are generally known) which control the flow of water to the turbines. In the Mauvoisin project, this relief is provided by means of a surge chamber into which the pressure intake gallery is directed. This surge chamber runs from the turbines at the bottom of the open air at a point above the reservoir water level, and is nearly vertical. It is 13 ft. in diameter, and is constructed in the solid rock.

UNDERGROUND POWER STATION

The power station at Fionnay is completely enclosed in an underground chamber, cut in the rock. The three Francis turbines, which run at 750 r.p.m. take in 15 cu. yds of water per second, and when the water has delivered up its energy it flows through a tunnel to the compensation basin outside the power station, in the open air. The level of the tail-race tunnel is 11 ft. higher than the turbines, to prevent the possible ingress of air to the turbine chamber, which would set up water

FIG. 7. Installations used for the construction of the dam. (1) Bank of material. (2) Primary crushing plant. (3) Gravel- and sand-preparing plant. (4) Stocks of separated gravel and sand. (5) Cement silo. (6) Concrete-making tower. (7) Machine room for cableway. (8) Cableway.

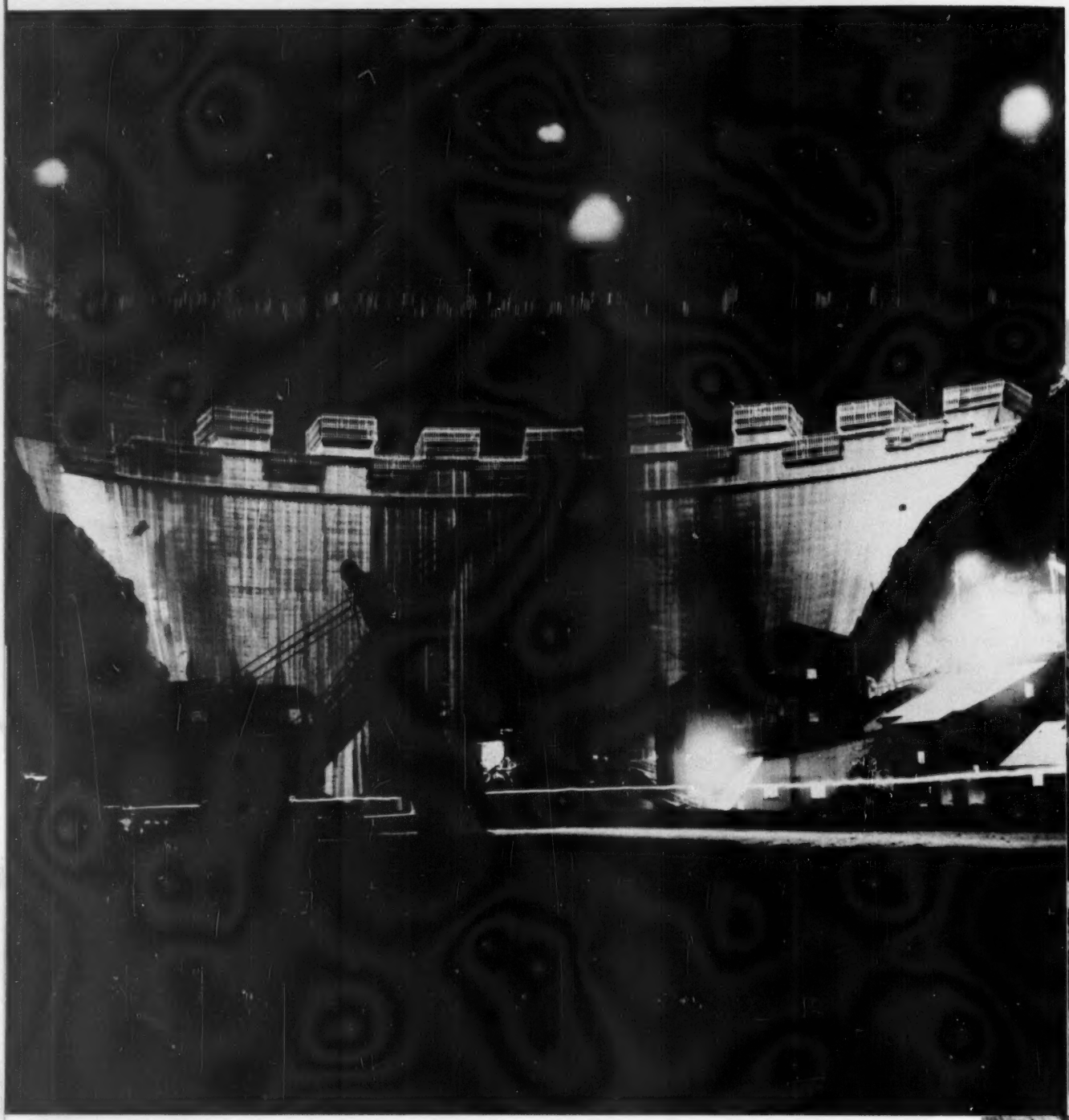


FIG. 8. Working by night.

FIG. 9. (*Below*) Mauvoisin Dam and Village with the Giétroz Glacier in the background.

hammer and other undesirable effects.

The Mauvoisin project operates in two stages. After the water has passed through the Fionnay power station, and emerged into the compensation basin outside, it takes on additional water from nearby catchment areas and it then flows through a further tunnel, which is 9 miles long and has a diameter of 10 ft. This alone is a remarkable feature of the project.

The tunnel from the Fionnay station, as with the first pressure intake gallery, emerges into the surge chamber associated with the power station at Riddes, which is also in the form of a vertical shaft. From this point two penstocks, each 1933 yds long, carry the water to the Riddes power station, which has a capacity of 225,000 kW distributed among 5 units. The turbo-generators at Riddes operate under a head of 3385 ft., whereas the water-wheels at the Fionnay station are of the Francis type, and constitute a technical advance of another kind in the sense that this is the first time that Francis turbines have been employed for a head as high as 1580 ft. The Pelton wheels (of which there are two for each generator) at Riddes are well within the limit for this type of turbine.

An interesting feature of the Riddes station is that the generators are cooled by means of a circulating water system, and the heat, instead of being wasted, is recovered by means of a heat pump and used not only to warm the power station but also the dwelling-houses of the staff.

The Mauvoisin project, which is among the outstanding hydro-electric developments anywhere in the world, will give a total output of 761 million units of electrical energy a year, and has added 352·5 MW to the Swiss resources of water power, which at present include 3600 MW, with 1250 MW still under construction. The Mauvoisin plant provides about 6% of the total Swiss demand, and from another point of view could be considered as almost equal in itself to the increase of generating plant called for in an average year at the present time.

(*The Editor is grateful to Mr J. H. M. Sykes, an expert in the field and a frequent contributor to* DISCOVERY, *for revising the original manuscript.*)

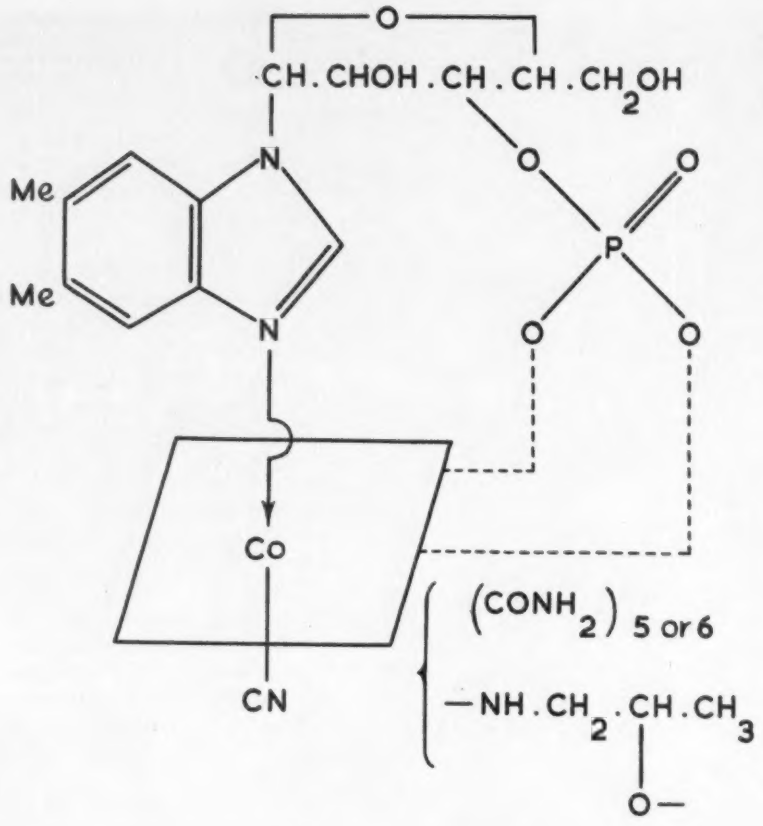


FIG. 1.

VITAMIN B_{12}

A. W. JOHNSON

Professor of Organic Chemistry, The University, Nottingham

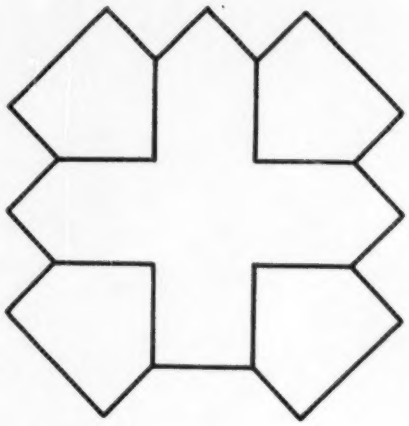


FIG. 2.

In 1926, two American biochemists, Minot and Murphy, reported that whole liver was effective in treatment of certain cases of pernicious anaemia, and their claim provided the stimulus for chemists to attempt the isolation of the compound responsible for the biological effect. Twenty-two years elapsed before this goal was realised, and then in 1948 the pure antipernicious anaemia factor, now known as vitamin B_{12}, was isolated almost simultaneously in two different laboratories by K. Folkers and his colleagues at Merck and Company Inc., New Jersey, and by E. Lester Smith of Glaxo Laboratories Ltd., in England. Whereas the latter team used only clinical testing during the isolation work, the Americans utilised the important observation that vitamin B_{12} also acts as a growth factor for several micro-organisms, and thus they were able to develop a test which was much more rapid and accurate.

When finally isolated as a deep-red crystalline solid and tested for activity in the clinical treatment of pernicious anaemia, positive responses were obtained from doses of only 0·5 to 5 μg. daily. Vitamin B_{12} is thus one of the most potent of all physiologically active compounds. The complexity of the isolation of the vitamin from liver naturally led to searches for other sources, and very soon another communication from the Merck laboratories reported its isolation from the culture broths of *Streptomyces griseus*, the strain used for the production of streptomycin. Later work showed that vitamin B_{12}, or closely related compounds, was present as a by-product in the waste liquors resulting from the production of a number of antibiotics, but it is now more usual to employ special fermentations for the production of the vitamin. The other members of the vitamin B_{12} group have been examined in detail. They all result from fermentation processes and, although most show some microbiological activity, only one or two other than vitamin B_{12} itself have clinical value in the treatment of anaemia. Appreciable quantities of these substances are also present in sewage sludge, but the difficulties involved in the separation of the mixture of closely related substances precludes commercial exploitation at present.

Not a great deal is known of the precise biochemical function of vitamin B_{12}. It is probably the main constituent of the animal protein factor and as such possesses valuable growth-promoting properties for feeding stock such as pigs and poultry. Although many of the ambitious claims for varied therapeutic applications of the vitamin should be treated with caution, all of the early successes in the treatment of anaemia have been amply confirmed. It is probably identical with the anti-anaemia "extrinsic factor", the intrinsic factor required to produce maximal beneficial results being a protein.

The vitamin was found to possess the formidable molecular formula $C_{63}H_{88}O_{14}N_{14}PCo$, a unique feature being the presence of the cobalt atom which, by magnetic measurements, was shown to be trivalent. Preliminary chemical studies were carried out on very small quantities of material but several significant portions of the molecule were revealed by hydrolytic experiments. Thus the existence of a cyanide group, a propanolamine, $CH_3.CHOH.CH_2NH_2$, group as well as 5 : 6-dimethylbenziminazole, later shown to

be present as the 3′- (or 2′-) phosphate of the corresponding 1-α-D-ribofuranoside, were demonstrated within a period of a few months. Furthermore, it was deduced that the cobalt was attached to the other nitrogen atom of the benziminazole nucleus through a co-ordinate bond and it was noted that an appreciable quantity of ammonia (5 to 6 moles) was liberated during acid hydrolysis and probably had its origin in the hydrolysis of several primary amide groups. All of these observations were expressed in the partial structure I.

It might be mentioned at this stage that the other members of the vitamin B_{12} family mentioned above differ from structure I in that they contain other heterocyclic bases, frequently purines, in place of 5 : 6-dimethylbenziminazole. The next major advance was the isolation of a crystalline cobalt-containing hexacarboxylic acid from a vigorous alkaline hydrolysis of vitamin B_{12} by Cannon, Johnson, and Todd in Cambridge in 1954. This acid, $C_{46}H_{60}O_{13}N_6CoCl.2H_2O$, has spectral characteristics similar to those of vitamin B_{12}, suggesting that the chromophore had not undergone marked change. This crystalline acid was submitted to Dr D. C. Hodgkin at Oxford for crystallographic examination, and in the course of a brilliant piece of X-ray analysis, she and her colleagues were able to construct the general pattern of the nucleus (II) and eventually, with the help of the known chemical properties of the acid, its total structure was deduced. After this the electron density patterns for crystals of vitamin B_{12} became easier to interpret, and in 1955 the total structure III was announced. The chromophore is somewhat related to those of the porphyrins and chlorophyll, and, indeed, it has been found that haemin, chlorophyll, and vitamin B_{12} all have a common biogenetic precursor. The structure of this latest addition to the B group of vitamins is one of the most complicated of all naturally occurring substances known at the present time and its elucidation is a remarkable example of a combined effort of scientists of varied disciplines, organic chemistry, crystallography, biochemistry, and physics.

For the future the synthesis of III presents a severe challenge to the chemist but experiments are already under way and small but significant advances have been made.

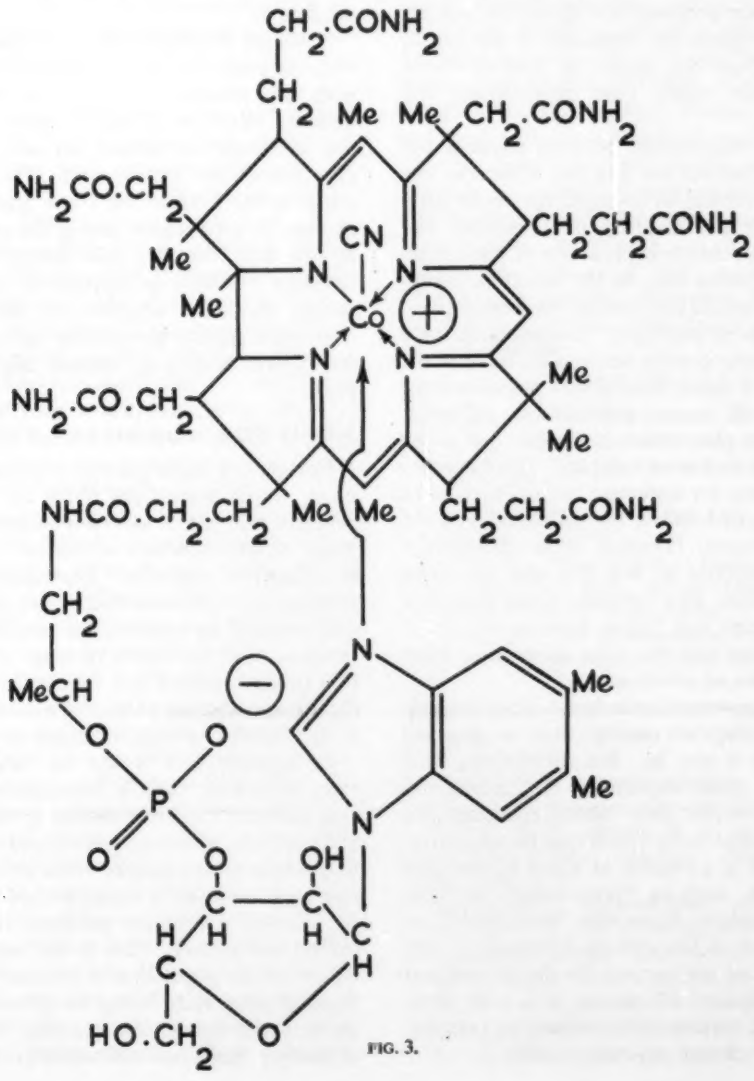


FIG. 3.

VITAMIN B_{12}

A. W. JOHNSON

Professor of Organic Chemistry, The University, Nottingham

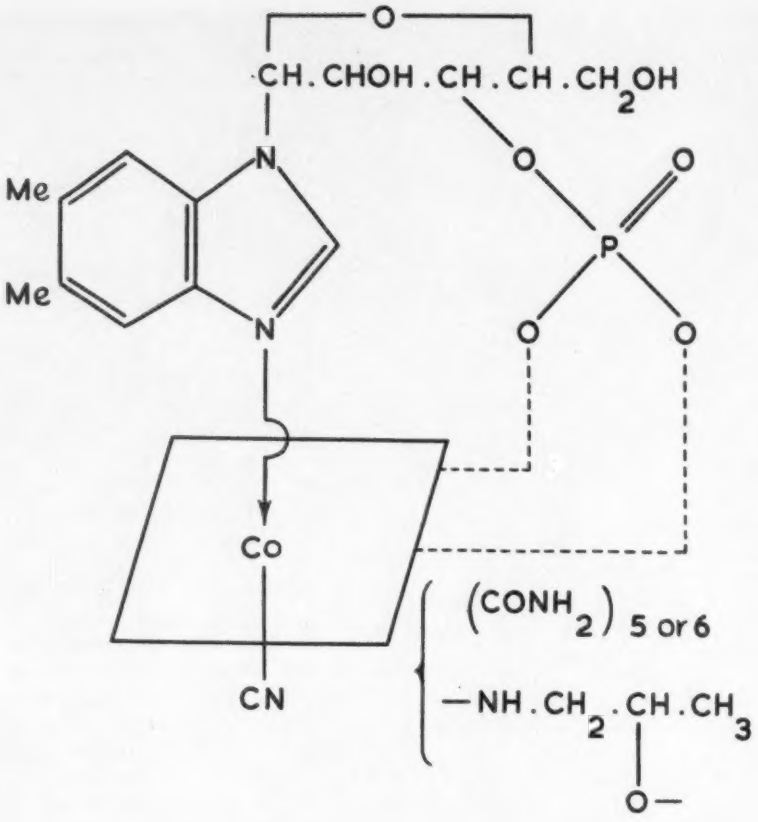


FIG. 1.

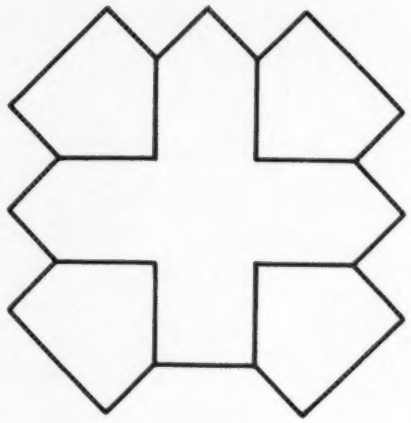


FIG. 2.

In 1926, two American biochemists, Minot and Murphy, reported that whole liver was effective in treatment of certain cases of pernicious anaemia, and their claim provided the stimulus for chemists to attempt the isolation of the compound responsible for the biological effect. Twenty-two years elapsed before this goal was realised, and then in 1948 the pure antipernicious anaemia factor, now known as vitamin B_{12}, was isolated almost simultaneously in two different laboratories by K. Folkers and his colleagues at Merck and Company Inc., New Jersey, and by E. Lester Smith of Glaxo Laboratories Ltd., in England. Whereas the latter team used only clinical testing during the isolation work, the Americans utilised the important observation that vitamin B_{12} also acts as a growth factor for several micro-organisms, and thus they were able to develop a test which was much more rapid and accurate.

When finally isolated as a deep-red crystalline solid and tested for activity in the clinical treatment of pernicious anaemia, positive responses were obtained from doses of only 0·5 to 5 μg. daily. Vitamin B_{12} is thus one of the most potent of all physiologically active compounds. The complexity of the isolation of the vitamin from liver naturally led to searches for other sources, and very soon another communication from the Merck laboratories reported its isolation from the culture broths of *Streptomyces griseus*, the strain used for the production of streptomycin. Later work showed that vitamin B_{12}, or closely related compounds, was present as a by-product in the waste liquors resulting from the production of a number of antibiotics, but it is now more usual to employ special fermentations for the production of the vitamin. The other members of the vitamin B_{12} group have been examined in detail. They all result from fermentation processes and, although most show some microbiological activity, only one or two other than vitamin B_{12} itself have clinical value in the treatment of anaemia. Appreciable quantities of these substances are also present in sewage sludge, but the difficulties involved in the separation of the mixture of closely related substances precludes commercial exploitation at present.

Not a great deal is known of the precise biochemical function of vitamin B_{12}. It is probably the main constituent of the animal protein factor and as such possesses valuable growth-promoting properties for feeding stock such as pigs and poultry. Although many of the ambitious claims for varied therapeutic applications of the vitamin should be treated with caution, all of the early successes in the treatment of anaemia have been amply confirmed. It is probably identical with the anti-anaemia "extrinsic factor", the intrinsic factor required to produce maximal beneficial results being a protein.

The vitamin was found to possess the formidable molecular formula $C_{63}H_{88}O_{14}N_{14}PCo$, a unique feature being the presence of the cobalt atom which, by magnetic measurements, was shown to be trivalent. Preliminary chemical studies were carried out on very small quantities of material but several significant portions of the molecule were revealed by hydrolytic experiments. Thus the existence of a cyanide group, a propanolamine, $CH_3 . CHOH . CH_2NH_2$, group as well as 5 : 6-dimethylbenziminazole, later shown to

be present as the 3′- (or 2′-) phosphate of the corresponding 1-α-D-ribofuranoside, were demonstrated within a period of a few months. Furthermore, it was deduced that the cobalt was attached to the other nitrogen atom of the benziminazole nucleus through a co-ordinate bond and it was noted that an appreciable quantity of ammonia (5 to 6 moles) was liberated during acid hydrolysis and probably had its origin in the hydrolysis of several primary amide groups. All of these observations were expressed in the partial structure I.

It might be mentioned at this stage that the other members of the vitamin B_{12} family mentioned above differ from structure I in that they contain other heterocyclic bases, frequently purines, in place of 5 : 6-dimethylbenziminazole. The next major advance was the isolation of a crystalline cobalt-containing hexacarboxylic acid from a vigorous alkaline hydrolysis of vitamin B_{12} by Cannon, Johnson, and Todd in Cambridge in 1954. This acid, $C_{46}H_{60}O_{13}N_6CoCl.2H_2O$, has spectral characteristics similar to those of vitamin B_{12}, suggesting that the chromophore had not undergone marked change. This crystalline acid was submitted to Dr D. C. Hodgkin at Oxford for crystallographic examination, and in the course of a brilliant piece of X-ray analysis, she and her colleagues were able to construct the general pattern of the nucleus (II) and eventually, with the help of the known chemical properties of the acid, its total structure was deduced. After this the electron density patterns for crystals of vitamin B_{12} became easier to interpret, and in 1955 the total structure III was announced. The chromophore is somewhat related to those of the porphyrins and chlorophyll, and, indeed, it has been found that haemin, chlorophyll, and vitamin B_{12} all have a common biogenetic precursor. The structure of this latest addition to the B group of vitamins is one of the most complicated of all naturally occurring substances known at the present time and its elucidation is a remarkable example of a combined effort of scientists of varied disciplines, organic chemistry, crystallography, biochemistry, and physics.

For the future the synthesis of III presents a severe challenge to the chemist but experiments are already under way and small but significant advances have been made.

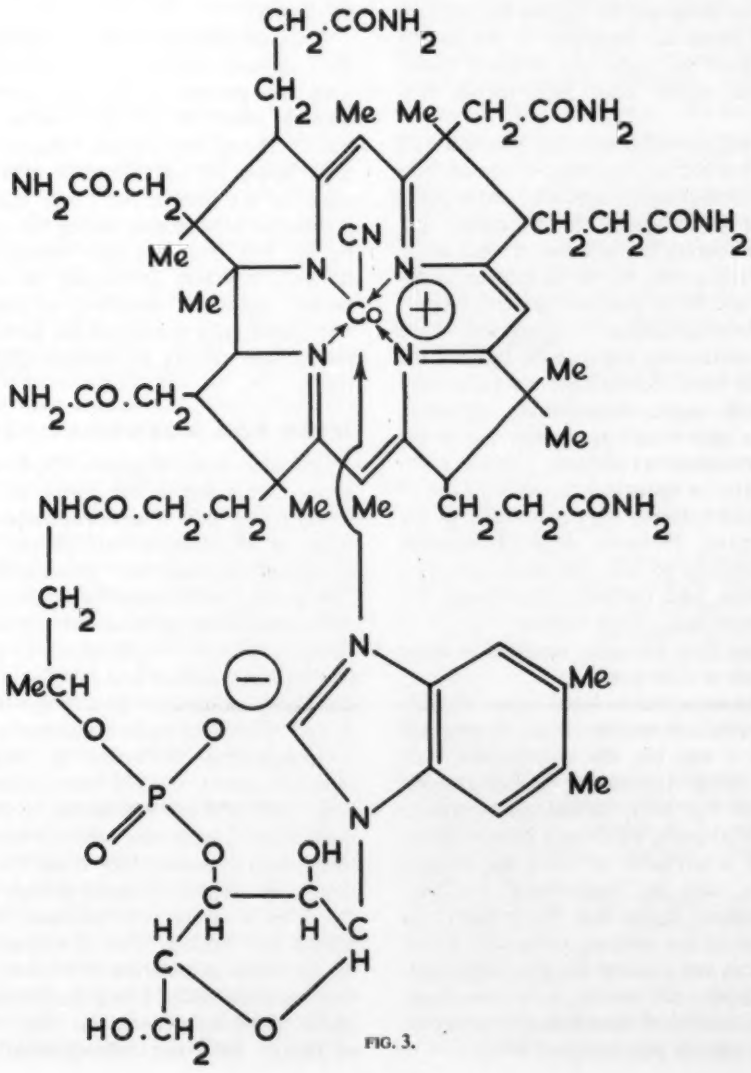


FIG. 3.

STATURE AND MENTAL FACULTIES

EUGENE SCHREIDER

Professor at the Institute of Demography, Paris

For a very long time physical and mental characteristics have been thought of as closely related. The lines of the hand, the cast of the features, the build of the body, all these appear on the long list of signs which "reveal personality". Gall, who was born two centuries ago, really believed that irregularities of the cranial surface were closely related to moral qualities: strange error for a responsible anatomist, who, fascinated by his own theory, did not notice that there is no connexion at all between the external shape of the skull and the surface of the brain. More recently, an author proposed to explore the interior of the mouth so as to probe the mysteries of the human soul. If this method were the right one, dentists would know more about our minds than psychiatrists and confessors.

Pearson looked for relationships between physical and mental characteristics, but did not find any. Paterson, in a general review of the problem which appeared about thirty years ago, stated that the majority of researches had proved nothing. But a possible explanation of some negative or contradictory results may be the failure to recognise disturbing causes, which can conceal low correlations.

Today, especially where psychiatry is concerned, some authors accept a close relationship between the build of the body and the cast of the mind. Kretschmer has elaborated this theory, which still exerts considerable influence. Sheldon has outlined a plan which is similar, but at the same time more flexible and more complex. There is probably some truth in all this, for statistical checks have shown that relationships do exist between the peculiarities of the body and those of the mind. However, these relationships are indicated by correlations so low that they are often considered of little value, and certainly leave room for doubt. Eysenck considers that "these findings are not of great importance because they are quite unsuited to serve the demands of diagnosis or selection".

Eysenck is right in the sense that in fact it is not possible to recognise a psychological quality from a physical characteristic, whatever it may be. But correlations, even low ones, may be of great importance to fundamental research. They can show that some mental characteristics have an organic or physical basis, which may be hereditary. However, in research it is advisable to avoid all complex and ill-defined notions, such as "body-build" or "personality". Statistical analysis shows that "body-build", as it is understood by most of the authors, represents a very faint tendency which does not account for the largest part of the anatomical variation. Of course, it is even more difficult to give a solid statistical foundation to complex aggregates of arbitrarily chosen psychological traits.

If, as is logical, one looks for correlations between relatively simple characteristics, one can experiment, for example, by choosing stature, on the one hand, and the results of one or several intelligence tests on the other. Long ago Bertillon wrote that stature is a characteristic which is "difficult to measure". However, it does not comprise the uncertainties of "body-build". Intelligence is a very complex function, whose nature is still seriously discussed. But the results of a test, where an individual must give a certain output, permit comparisons, whatever theory may be preferred. The author has subjected several hundred French soldiers to an intelligence test, that of Prof. Penrose, and discovered a correlation equal to 0·29 between stature and the results of the test (see Table I).

This correlation is low, but highly significant: there is less than one probability in a hundred that it is due to chance. The collection of soldiers was then divided into three groups according to their social category: with slight numerical fluctuations the correlations remained significant within each group. This gives rise to the belief that correlation is not attributable to social or cultural factors, which may perhaps lessen it, but do not seem to produce it.

A second experiment on a smaller group was then tried with the same test. It gave similar results, as was the case with two groups of Parisian workmen, who underwent different tests. In all, six samples out of eight gave low but significant correlations between stature and the results of *different* intelligence tests. The two exceptions were pilots of the French Air Force and rail-car drivers. The absence of correlations among the pilots may be explained by the fact that they had undergone a very strict preliminary selection in respect of stature, in addition to mental tests; this selection, as psychologists know very well, must have destroyed the correlation. In the case of the rail-car drivers no definite explanation has yet been found.

NEED FOR ADEQUATE TEST CONDITIONS

However, a more general explanation must be kept in mind. Psychologists are trying to carry out tests whose solution will not in any way depend on acquired knowledge, or on a standard of culture. In practice, such a test is difficult to conceive. Knowledge and cultural habits vary greatly within modern communities, which are highly differentiated by professional specialisation. Cultural differences affect the results of tests. If therefore the correlation between stature and intelligence is naturally low, the disturbing influence of mental habits can sometimes reduce it, and sometimes make it disappear altogether.

Consequently, it would be interesting to carry out research among socially homogeneous groups. But it is very difficult, if not impossible, to discover among modern communities, with their complex social structure, a population which is satisfactory from this point of view. Even that most uniform of social groups distributed throughout the French Army, the peasants, conceals differences of station and culture. That is why research was undertaken on an Indian population in Mexico: a group of Otomis, a farming community, living traditionally without any appreciable social differences, and who, from the point of view of culture have one characteristic in common: they can

TABLE I

Correlations between stature and the Penrose intelligence test—French soldiers—20–22 years (Schreider, 1956)

Group	*Number of subjects*	*Correlation coefficient*
Total series	567	0·29
Town dwellers		
Manual workers whose work does not involve great physical effort	144	0·31
Manual workers whose work involves great physical effort	265	0·18
Peasants	158	0·28

TABLE II

Correlations between stature and several performance tests—Otomi Indians, Mexico (Schreider, 1956)

Tests correlated to stature	*Number of subjects*	*Correlation coefficients*
Correlations, zero order		
Form-Board	58	0·35
Minnesota	80	0·31
Cubes of Kohs	82	0·29
Multiple correlations		
Form-B. and Minnesota	58	0·38
Form-B. and Kohs	58	0·38
Minnesota and Kohs	80	0·34

neither read nor write. Of course, performance tests had to be used, i.e. intelligence tests requiring only manual actions.

EXAMINATION OF HOMOGENEOUS GROUP

In this homogeneous population, which has no appreciable difference in culture, and which is therefore preserved from any of its disturbing influences, correlations between tests and stature appear *higher than among European populations.* And if multiple correlations are calculated between stature and tests, taken two by two, the coefficients approximate to 0·40, which is far from negligible (see Table II).

Thus, a correlation exists between stature and mental faculties. It is shown most clearly when disturbing influences, such as social and cultural differences, are eliminated, since these affect, to a greater or a less degree, the results of the tests. The correlation is not high, and it is quite evident that the stature of an individual cannot inform us as to his intelligence. But it shows that intelligence, in all its variations, is related to organic causes. What these causes are, correlation obviously cannot tell us.

From the biological point of view, stature is rather a rough characteristic. However, since they are correlated, stature and intelligence obey a common factor. But this factor is not necessarily represented by an easily isolated physiological function. It may, as a matter of fact, be the result of a number of independent causes.

Numerous researches have shown that on the average students are taller than young manual workers. It is possible that the correlation between stature and mental faculties intervenes in this differentiation. One might believe that this correlation is produced by unequal living conditions, which are more favourable in the case of students, either from the mental or the physical point of view. But this explanation does not seem tenable. More than thirty years ago an anthropological study appeared which, among other things, gave us information about the stature of a specimen group of Ukrainian conscripts. At first sight, as so often in anthropometric research, this seemed to show that intellectuals were taller than manual workers. But, in fact, the figures referred to conscripts who all belonged to the same peasant environment, who were natives of the same district and who had hardly begun to follow different paths, or perhaps had only expressed vague wishes. Nevertheless, the difference between the stature of the alleged intellectuals and that of the manual workers and peasants is statistically significant. Here lies the interest of this human group, which reflects no great differentiation, but only *different aspirations in a fundamentally homogeneous population.* After all, the correlation found among the Otomis testifies to the same thing, and this cannot be explained by unequal living conditions, since it concerns a socially homogeneous population.

It would be a pity if these findings were to be misunderstood and an attempt made to measure intelligence by inches. It would be just as dangerous to infer from a particular correlation a social selection due to purely biological, or even hereditary, causes. Correlation is not high, and social selections reflect a great number of factors, including survivals from the past which no longer correspond to the present situation. Culture may also play as important a part as biology. But for anyone looking for the biological conditions of mental variations, the correlation between stature and the results of intelligence tests is important. It shows that more subtle biological characteristics than that of stature deserve to be studied from this point of view. Nevertheless, to clear the ground, it would be wise to concentrate first on isolated characteristics rather than on complex anatomical, physiological or mental combinations, such as "body-build", "constitutional type", or "personality".

READING LIST

Eysenck, H. I., "Dimensions of Personality", London, Kegan, Paul, Trubner & Co., 1947.

Kretschmer, E., "Körperbau und Charakter", Berlin, Springer, 1927.

Paterson, D. G., "Physique and Intellect", New York, Appleton Century, 1930.

Pearson, K., "Relationship of Intelligence to Size and Shape of the Head and other Mental and Physical Characters", *Biometrika*, 1906, vol. 5, pp. 105–46.

Rogers, W., "La Buccomancie, ou l'art de connaître le passé, le présent et l'avenir d'après l'inspection de sa bouche", Paris, 1851.

Schreider, E., "Recherches anthropologiques sur les Otomis de la région d'Ixmiquilpan, Part II", *L'Anthropologie*, 1955, vol. 59, pp. 253–6.

——, "Taille et capacités mentales, étude expérimentale et statistique", *Biotypologie*, 1956, vol. 17, pp. 21–37.

Sheldon, W. H., Stevens, S. S., and Tucker, W. B., "The Varieties of Human Physique", New York and London, Harper, 1940.

Sheldon, W. H., "Atlas of Men", New York, Harper, 1954.

Tchistiakov, G. A., "Natsionalnyie i sotsialnyie razlittchia v fizitcheskom razvitii prizyvnych", *Materialy po Antropologuii Oukrainy*, Kharkov, 1926, pp. 77–104.

Vallois, V. H., and Ackerknecht, E. H., "François-Joseph Gall et sa collection", *Mém. Mus. Nat. Hist. Nat.*, 1955, n.s., A., vol. 10, 1–92.

THE INTERNATIONAL GEOPHYSICAL YEAR

MONTH BY MONTH

Compiled by Angela Croome

TABLE OF MAN-MADE OBJECTS CURRENTLY IN ORBIT

(Accurate to day of going to press, August 15)

Maker's Name	*Astronomers' Name*	*Up*	*Down*	*Shape and Size*	*Angle to Equator*	INITIAL ORBIT: *Period*	INITIAL ORBIT: *Distance from Earth*	*Orbital Life*	*All-up Weight*	*Pay-load*	*Used for Measuring*	*Principal Scientific Value*	RADIO: *Characteristics*	RADIO: *Radio Life*	RADIO: *Other Points*
Explorer I (rocket case with instrumented nose-cone)	1958 α	Jan. 31, 1958	1959	Tube, 80×6 in.	33·6°	114 mins	219 to 1587 miles	One or more years	30·8 lb.	10 lb.	Inside and outside air temperature, cosmic rays, micrometeorites	Cosmic ray intensity studies	108 Mc/s high power. 108·03 Mc/s low power	2½ weeks 3 months	—
Vanguard I (instrumented sphere)	1958 β2	Mar. 17, 1958	2158 roughly	Sphere, 6·4 in. diam.	34·1°	134 mins	404 to 2466 miles	200 years	3½ lb.	3½ lb.	Temperature difference, inside and outside	Testing solar cells	108 Mc/s high power. 108·03 Mc/s low power	2 weeks. Indefinitely while in sun	6 silicon solar "converters"
Vanguard I (rocket case)	1958 β1	Mar. 17, 1958	1963+	Tube, 48×20 in.	34·1°	134 mins	404 to 2466 miles	5+ years	50 lb.	—	—	—	—	—	—
Sputnik III (instrumented nose-cone)	1958 δ2	May 15, 1958	Late 1959	Cone, 11·7×5·6 ft.	64·9°	106 mins	140 to 1160 miles	1½ years	2806 lb.	2134 lb.	Twelve experiments on conditions in space	Radiations outside the Earth's atmosphere	20·005 Mc/s (tracking and telemetry)	Nearly indefinitely	Powered by both solar and chemical batteries
*Sputnik III** (rocket-case)	1958 δ1	May 15, 1958	1959	Tube, 30 ft. long	64·9°	106 mins	140 to 1160 miles	About 1 year	600 lb.	—	—	Aerodynamic studies	—	—	—
Explorer IV† (rocket-case with instrumented nose-cone)	1958 ε	July 26, 1958	1959	Tube, 80×6 in.	51°, (launched in northerly direction)	110 mins	163 to 1365 miles	More than 1 year	38 lb.	18 lb.	Counters for identifying radiation observed by previous *Explorers*	Identification of intense radiation belt above 600 miles up	108 Mc/s high power. 108·03 Mc/s low power.	Some weeks. Some months	—

* Note: *Sputnik III* contributed three other orbiting pieces besides satellite and rocket; namely, two halves of the nose-cone sheath and a nose-cone probe. These have no radio and are no longer visible.
† *Explorer II* was launched but did not go into orbit. Only successful *Vanguards* and *Sputniks* are given numbers. *Explorer III* came down on June 27. It was in orbit three months.

Visit to Ruwenzori Glaciers

In January of this year four members of the staff of Makerere College, Uganda, carried out a sixteen-day reconnaissance of the glaciers on the Ruwenzori, the mountains sometimes known as the "Mountains of the Moon", which lie on the Equator at the border of Uganda and the Belgian Congo. The visit was intended as a preliminary assessment of the problem of keeping the ice-budget of the Ruwenzori under review, to give expedition members experience on the mountain, and to build a hut above the snow-line as a basis for a continuing programme of visits. When glaciological studies for the IGY were at the planning stage it had not been thought possible to mount an expedition to Ruwenzori even on a modest scale, though study of this little-known equatorial glaciation was strongly urged. (See DISCOVERY, IGY Notes, June 1956.) The arrival in 1957 of two new members of the Makerere staff with experience of ice-work changed the situation. This preliminary reconnaissance expedition was organised within two months to take advantage of one of the two annual periods of low rainfall, and substantially achieved its objects at a cost of £182.

The specially designed hut was erected at about 15,000 ft., close to the Elena glacier, on which a base-line for future measurements of glacier movement was carefully surveyed and marked. (All equipment, including the hut sections, had to be brought up from 6000 ft. as head-loads by porters.) A list of the thirty-one glaciers of the Ruwenzori was prepared, giving their positions and names, with a comparison of the data on them accumulated by the few previous expeditions that had taken note of the glaciation (six and possibly seven of the Ruwenzori glaciers have not as yet been named). A considerable photographic programme was carried out, using both normal- and long-focus lenses, and it is expected that the albums prepared from these pictures, to be deposited at the appropriate world data centre, will prove later on most useful for comparative studies of ice retreat. The official report of the reconnaissance comments:

> "The value of orientated photographs taken from marked sites has proved to be very great. Comparison of certain of our prints with photographs published in the Duc D'Abruzi's account of his 1906 expedition has been of great value in our work. It shows clearly that there has been a considerable deglaciation of the Stanley massif during the last 50 years; an observation which conforms with trends elsewhere in the world."

On the other hand, the placing of markers in the ice was largely frustrated and none of those placed by previous parties (the most recent being that of 1952) was of any use; only one was found and this could not be identified. The leader remarks:

> "During our marking-work, we discovered, as did the expedition to Mt Kenya . . . that the ice of the tropics is different in nature from that of the temperate regions. It appears to be both harder and tougher and may require the development of new drilling techniques for its proper investigation. Perhaps the presence here of two complete precipitation-ablation cycles during the year leads to the development of quite different internal micro-structures in the glacier-ice proper."

A second visit to Ruwenzori to continue the work is planned this year and thereafter regularly on this same relatively small scale since (to quote the report)

> "this method of attack is more likely to add substantially to our knowledge of the glaciology and other aspects of the region than the mounting of larger expeditions at less frequent intervals."

F. P. Henderson of Makerere College was expedition leader and geologist. (*Miss A. Croome was attending the IGY Conference in Moscow at the time we went to press; her full report will be published next month.*)

IGY in Mexico. By Miss I. Nicholson

Mexico City is the centre for IGY studies in Mexico itself and in Central America. The authorities here are working in close co-operation with various U.S. bodies, such as the Scripps Institute of Oceanography, the Inter-American Geological Survey, and the Universities of Chicago and Wisconsin; and in Mexico itself help is being received from a number of Government Departments, including the Admiralty and the Departments of Agriculture, Livestock, and Communications. When interviewed by your correspondent, one of the directors of IGY studies, Dr Julián Adem, said that one very important result had been achieved by the publicity given to the IGY: more funds were coming in than ever before, which could be used on essential research, and there was greater public interest in science.

In Mexico, the most interesting finding so far has been in relation to aurora, two having been observed since the opening of the Year, one in September 1957 at latitude 29°, and the other on the night of February 10–11 of this year which was visible throughout Mexican territory—that is as far south as latitude 15° N. Both aurorae were, of course, very unusual occurrences so close to the Equator.

The observatory at Tonantzintla, near Puebla, has a Lyot-type filter being used on the 12-cm. telescope with 180-cm. aperture. At this observatory the main observations of the satellites are being made (though amateurs throughout the country are on the look-out too), World Days are being kept, and sunspots studied.

New equipment for vertical sounding of the ionosphere has been acquired from the U.S.A.: model C-4 of Barker Williamson manufacture.

Glacial studies are being made on the three peaks with permanent ice-caps: Orizaba (18,850 ft.), Popocatépetl (17,981 ft.), and Iztacíhuatl (17,240 ft.). Investigators have spent considerable periods at camps at these altitudes. Your correspondent has been as high as about 16,000 ft. on Popocatépetl, and can vouch for the tremendous changes of pressure and temperature to which the mountain is subjected. Lips blister in a few moments in the scorching day sun, but even at noon, in the shadow of a boulder, one's teeth chatter with cold. In the sun the glacier water melts quickly and makes little rivers, and in many parts the volcanic rock crumbles to a thick heavy sand, which makes climbing difficult.

The lower of two camps on Popocatépetl, with two Mexican scientists.

Oceanographic expeditions have been made to the Revillagigedo Islands southwest of the Lower-California Peninsula, and to the island of Guadalupe, farther to the north, and here, as at seven Atlantic stations, tide-gauges are being operated. An electronic computor which has recently been acquired by Mexico City University will be used for calculating tides.

Radio sonde observations are being made at four stations at least once daily, and this programme is intensified on special World Days. Records of total radiation of sun and sky are being made, and there is continuous recording of the diffuse sky radiation, samples of air being taken monthly for determination of carbon-dioxide content, and monthly sample of precipitation for chemical analysis.

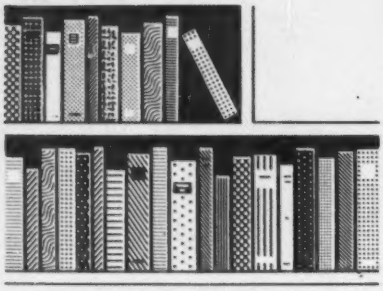
A magnetic observatory is carrying on normal registration of D, H, and Z components, and absolute observations to determine the base-line are also being made. Observations with an H-storm magnetograph are carried out at Tonantzintla.

Cosmic-ray measurements are being made at the University Station in Mexico City, using a Compton Bennet camera and a neutron counter (University of Chicago model). At another station, measurements are being made with a coincidence telescope.

Seismic measurements are being made at ten stations, three of which also take measurements of micro-seisms. The earthquake which shook Mexico City in July 1957 and brought down some large modern buildings was more useful for engineering studies to assist architects in the future than for IGY data in particular. Studies of the Earth's crust are being made, and the relationship between micro-seisms and meteorological conditions investigated.

Thirteen stations are making observations of particular air-borne fission product activity at ground-level. Laboratory studies are being undertaken to determine the quantity of strontium 90 and cesium 137 in milk.

The Tacubaya Station is making determinations of latitude by means of the Horrebow-Talcott method. Longitude is obtained by determining time by the meridian transit method and automatically recording the signals that are received from the WWV Station of the National Bureau of Standards.



THE BOOKSHELF

A History of Technology, Vol. IV

Edited by C. Singer, E. J. Holmyard, A. R. Hall, and T. I. Williams, "The Industrial Revolution, *c.* 1750–*c.* 1850" (*Clarendon Press: Oxford University Press, 1958, xxxiii+728 pp., 48 plates; also 349 figures in the text, £8 8s.*)

In a review (DISCOVERY, 1958, vol. 19, No. 6) of the third volume of this splendid series, attention was drawn to the problem of periodisation which the editors of a comprehensive work of this nature have to face, and an attempt was made to guide the reader, especially the selective reader, in the avoidance of the pitfalls inherent in the actual scheme adopted. Thus, a reader was warned that in searching for information about a particular branch of technology during a particular period he might have to look in a volume relating to a period different from the one concerned. While difficulties of this sort are here less glaring than in the earlier volumes it is probably in "mapping" the contents in relation to other volumes that a reviewer can most usefully discharge his task.

With the title of this volume—"The Industrial Revolution"—the editors are understandably not very happy. Though the hundred years here surveyed undoubtedly witnessed an accelerated transition to new forms of social and political structure, the reluctance to set aside the traditional view of the determinative importance of increased mechanisation and the coming of steam power in Great Britain has set many of the authors needless problems of relating their several topics to this supposed "revolution". Thus Prof. Forbes almost contradicts himself several times in the course of two pages (151–2) devoted to an analysis of the "Industrial Revolution". But what *was* the Industrial Revolution? The factory system? Mechanisation? Steam power? Rationalisation of productive capacity? Joint-stock liability? Urbanisation? Is the main emphasis to be technological, economic, social, or even political? (One writer justifiably stresses the importance of the French Revolution with all its reverberations.) Until this has been settled (if indeed any really useful purpose would be achieved thereby) any discussion of what factors most "contributed" to the "Revolution" is bound to remain merely circular. Perhaps the young technologist, for whom these volumes were originally planned, might be pardoned if he were to wonder what all the fuss is about. It is not without significance that one of the most satisfying articles in the volume—Mr Stowers on "Watermills"—makes no reference to the Industrial Revolution, but develops the subject from 1500, when European industry was almost entirely water-powered, down to the early 19th century when water mills were still giving way only slowly before the steam engine. The facts are allowed to speak for themselves, and those facts include the improvements in efficiency based on the *scientific* investigations of John Smeaton. Here, surely, is the paradigm of a scientifically conceived history of technology.

How do the other articles fit in with this view? More or less continuous with the corresponding articles in Volume III are those on farm techniques and implements, mining and metallurgy, spinning and weaving of textiles, glass, roads, waterways and bridges, water supply, shipbuilding, cartography, precision instruments. A few topics (ceramics, fish preservation, and sanitation), which received no more than passing mention in Volume III, are taken up again here in discussions which properly cover the intervening centuries: the very marked advance in sanitation, or rather a return to the standards of Imperial Rome, was a feature of the later "Industrial Revolution" commonly taken too little account of. Wholly novel in this volume are the accounts of the steam engine and steam power, coal gas, telegraphy (visual and electric), and machine tools. Of these, perhaps the introduction of "tools to make tools" and "machines to make machines", or at least their components, might be regarded as the most completely *revolutionary* feature of the period, at least on the industrial level. Nothing, it will have been noted, has yet been said about the chemical industry; for unlike the other basic sciences involved in industry, chemistry itself passed through its own "revolution" during the period under review. Some account of this critical phase, which involved both "revolution" and clarification, was therefore essential, and this has been ably supplied by Dr Holmyard as a preface to the sketch of the industrial repercussions by Dr and Mrs Clow: it is a pity that the latter authors were not able to utilise the recent work of Hardie (whose name is mis-spelt in the bibliography), Barker, and others, on the origins of the alkali industry.

The volume concludes with a study of the change from craft mystery to science as a basis for technology. This was an excellent idea; but the execution, it must be admitted, is somewhat disappointing. Prof. Ubbelohde was set a task impossible of fulfilment in the space at his disposal. For the experienced reader he has provided hints for some novel approaches (with Plato's views, which he cites from Plutarch, he might have compared those of Leon Battista Alberti), but an account which includes among "precursors" of the Royal Society Sir Walter Raleigh and omits Francis Bacon, the *Lincei* and the *Cimento* can hardly be recommended to a beginner. Here, it seems to the reviewer, we are paying the price of the most welcome speed of appearance of the successive volumes; for some editorial correlation could at least have given guidance to the scattered references to these "sources" (e.g. III, 718–9; 636–7). In the later stages, though Prof. Ubbelohde does indeed mention Lavoisier as a "consultant" (p. 674—omitted in index), neither here nor elsewhere is the focal importance of the Salpêtrière expounded.

If this notice appears to be mainly critical it is the reviewer's hope that this may be taken as a measure of the work's importance and of his own enjoyment of almost every word of it. The fact (as he believes) that its premature entanglement with the "Industrial Revolution" was misconceived, detracts not in the least from the much more important fact that here, as perhaps never before, has been presented a critical and comprehensive survey of such data as may enable historians of all kinds to form a more perceptive judgment of that fascinating period than has yet been achieved.

W. P. D. WIGHTMAN

Millions Still Go Hungry

(*Food and Agriculture Organisation of the United Nations, Rome, 1957, 102 pp., 5s.*)

> If all the world were apple-pie
> And all the sea were ink . . .

The problem of what to do *with* the ink is easily solved. It would be used up in writing and publishing books demonstrating that there is not only a world shortage of food in general, but also that what food there is tends to be deficient in protein. The more abundant foods,

A WONDERFUL MONEY-SAVING OPPORTUNITY FOR EVERY READER OF DISCOVERY!

FULL LENGTH FULL SIZE!

Now's the time to join the

Scientific Book Club

121 CHARING CROSS RD., LONDON, W.C.2

A FIRST-CLASS SCIENTIFIC BOOK EVERY MONTH FOR

ONLY 4/-

FREE GIFT

THIS HANDSOME

"Tidy Tub"

You can obtain a gay contemporary "TIDY TUB" Wastepaper Basket or Flowerpot Holder free if you enrol a friend in the Club. Send your friend's name and address with 5s. (4s. plus 1s. postage) for the first book, mentioning this offer, and your "Tidy Tub" will be sent to you.

Several other splendid gifts also available.

ALL THESE GREAT TITLES

Recent and forthcoming selections include:

AFFABLE SAVAGES
by Francis Huxley
Published at 25s.
4s. TO MEMBERS

★

ONCE ROUND THE SUN
by Ronald Fraser
Published at 16s.
4s. TO MEMBERS

★

ATOM HARVEST
by Leonard Bertin
Published at 20s.
4s. TO MEMBERS

★

THE PAST IN PIECES
by P. E. Cleator
Published at 21s.
4s. TO MEMBERS

★

MAN UNLIMITED
by Heinz Gartmann
Published at 18s.
4s. TO MEMBERS

The Scientific Book Club is owned and controlled by Foyles, the world-famous booksellers.

Here is a wonderful money-saving opportunity for every reader of Discovery! Each month, the Scientific Book Club brings to its members the fascinating story of the march of modern science, told in thoroughly dependable books by the front-rank scientific writers of our time—vivid, vital, constructive contributions to Man's unceasing struggle to solve the problems of the Universe.

And although the ordinary editions of these books are sold to the general public at 12s. 6d., 15s., or more, THE PRICE TO MEMBERS OF THE SCIENTIFIC BOOK CLUB IS ONLY 4s.! Remember, too, that Scientific Book Club selections are *full-length and unabridged*. They are printed on good-quality paper, well bound, with an attractive picture jacket.

These are, we say with certainty, books that you will be glad to read, proud to own. The Scientific Book Club brings these great books to you each month; helping you to build up, at remarkably low cost, a first-class collection of scientific books. **Now is the time to join!**

EXCELLENT PRODUCTION

Legible modern type is used for all Scientific Book Club selections. The pages are designed with ample margins and every book is carefully planned for comfortable reading. The Scientific Book Club's selections have been widely praised for the high standard of their production.

FILL IN THIS ENROLMENT FORM TODAY

To the Scientific Book Club, 121 Charing Cross Road, London, W.C.2

I wish to join the Scientific Book Club and agree to purchase the selected book issued each month to members at a cost of 4s. (postage 1s.). I agree to continue my membership for a minimum of six books and thereafter until I cancel.

You may enrol through your usual bookseller if he is a member of the Booksellers' Association.

Discovery/Sep. 58

☐ * **I will pay for selections on receipt.**
Or if you wish to save time, postage and postal-order costs, you may send an advance subscription. Six months 30s.; twelve months 60s.

☐ * **I enclose 30s./60s. (strike out amount not applicable).**

* Place √ in the space above, as required.

Name .....
BLOCK LETTERS PLEASE

Address .....

Overseas enrolments should be accompanied by an advance subscription. Prices as for inland (except South Africa, Australia, New Zealand)

though they are not all such poor sources of protein as apple-pie, badly need fortification. The improvements that we are looking for are not simply in the quantity of food produced but also in the quality. It will not be easy to get all the extra protein that is needed and the only criticism of this little book is that it may underrate the difficulty of the research that still remains to be done.

Every year at least fifty publications outline the miserable nutritional state of much of mankind. If exhortation were all that was needed, the governments of U.S.A., U.S.S.R., and U.K., which are the only ones that at the moment could do the job adequately, would long ago have taken up the problem of world feeding and solved it. But more pressure is needed. Public opinion will have to be much more thoroughly roused before we will be able to distract official science from dangerous and expensive frivolities like H-bombs and sputniks and force it to attend to the more difficult problem of feeding people.

This excellent book gives a vivid and critical account of many aspects of the work of FAO. If anyone should think that scientific work and administration are impersonal and mechanical processes, the stories told here will bring enlightenment. Bringing food and the knowledge of how to get it to under-developed countries is nearly as beset by personality problems as the theatre. It obviously calls for rather special and pleasant qualities in people.

The facts are clear; FAO knows them, and knows how to transform agriculture in a way that would go far towards abolishing world hunger. But only governments can take the necessary action. FAO is realistic and, in a tempered way, optimistic. One quotation may serve as an example ". . . even governments learn by experience; but this is a process involving many, many years, and even the wisest governments learn but slowly in this way. The best FAO can do, perhaps, is so to direct and emphasise experience that governments and their servants will learn more quickly." A few judicious kicks from the electorate would probably help too.

N. W. PIRIE

The Scallop: Studies of a Shell and Its Influences on Humankind

Edited by Ian Cox. Eight contributors. (*London, Shell Transport and Trading Co., 1957, 135 pp., limited number available to the public for 14s. 3d.*)

How exactly would a librarian classify such a book? It opens with a scholarly piece of etymological research; it proceeds to describe in detail (with "action photographs") how a mollusc behaves when attacked by a starfish; it discusses in learned fashion Greek terra-cottas, Byzantine sarcophagi, Pompeian wall-paintings, the origins of the shrine of St James of Compostela in northern Spain, symbolism in Renaissance paintings, some devices in heraldry, and Maya and Aztec decoration; and it ends with a chapter of practical culinary advice. Probably, noting the handsome binding and the many excellent colour plates, the librarian would decide to put it on the Art shelves—even though the starfish and the chef did not altogether fit in.

This book is a pleasure to handle, to look at, and to read. It indicates how wide and diverse a range of subject-matter may be suggested by one simple object, in this case a shell. Its eight authors include Sir Mortimer Wheeler on the shell as a symbol in ancient art, Mr James Laver on the shell as the "cradle of Venus" in pictures by various Renaissance masters, and Mr Christopher Hohler on the shell as the badge of St James, the patron saint of pilgrims. The book celebrates the Diamond Jubilee of the Shell Company, but the only mention of the company is in the Foreword, and of petrol in a single line of one chapter.

J. F. HORRABIN

The March of Photography

By Prof. Erich Stenger (*Focal Press, 1958, 302 pp., 42s.*)

For well over fifty years Prof. Stenger was an assiduous collector of everything appertaining to the history of photography—not only photographs, apparatus and books, but also information which he found in his perusal of German photographic magazines and newspapers, old and new. Friends and acquaintances were mobilised to look out for "titbits" on photography. These gleanings of information were methodically entered on index cards under numerous headings and subdivisions. There was hardly a photographic subject on which Stenger could not immediately pull out some references. A new photographic joke, listed under the heading "Jokes", was to him as interesting as a piece of information about aerial photography or early photographic societies—to take two examples at random—which would immediately be registered under these headings. In this collection of information Stenger showed much good sense and, being endowed with a sense of humour, he developed a particular liking for oddities. I remember very well how delighted he was with a pack of playing-cards with photographs of nudes on the back which I sent him as a small addition to his splendid collection. This was only a few months before his death last September at the age of 77. "Since I received them, I just can't do anything but play cards," he wrote.

The loss of the entire index at Brno, where it had been sent for safety, during the war was naturally a great blow, but luckily the material collected up to 1938 had been published in the first edition of this book, entitled "Die Photographie in Kultur und Technik". Dr Stenger was then professor of photographic chemistry at the Technische Hochschule in Berlin. In 1949 an enlarged edition appeared under the title "Siegeszug der Photographie". Some two years ago this reviewer was consulted as to the advisability both of bringing the text up to date and of adding information on British, French, and American photography in order to broaden the author's chauvinistic outlook. However, this would really have resulted in a different book, and the idea was consequently abandoned.

"The March of Photography" is based on the English translation of the first edition, which appeared in New York in 1939, but some of the first translator's annotations have been omitted, and the fresh material contained in "Siegeszug der Photographie" has been added by a different translator. The present publisher has also put in a few footnotes of his own without indicating them as such, and one in the author's preface is very misleading: "On a memorable visit to Observatory House at Slough, Sir John Herschel's home, his grand-daughter told *me* . . ." Prof. Stenger never visited England.

The omission from "The March of Photography" of the 80 pages of half-tone plates and numerous line illustrations in the text of the German edition is regrettable, for a book on photography lacking illustrations is like bread without butter or jam. Moreover, two guineas seems a high price for an unillustrated book of 300 octavo pages.

Prof. Stenger did not claim his book to be a history of photography in the usual sense. There is no continuous narrative of the evolution of photography, nor is there any attempt at chronological arrangement. The main part of the book consists of short pieces of information arranged under subject-headings without comment or explanation. Lack of documentation, so essential for further research and reference, deprives the book of much of its value for the serious student. It is too vague to say, "In 1858 one could read . . ." or "In 1893 someone wrote in America . . ." and so on without indication of source. Moreover, some of the information taken from newspapers and magazines is inevitably inaccurate, as popular newspaper reports frequently are today. It is useless to begin pointing out errors, there are too many, but I would mention that not a few are due to the

Scientific Research in British Universities

Outlines the projects being undertaken by research teams in the scientific departments of British Universities and University Colleges during the 1957–8 session. Name and subject indexes are included. **22s. 6d.** (*post* 1*s.*)

Research in 1957

The latest additions to the annual series of reports from the specialised organisations of the Department of Scientific and Industrial Research. Illustrated.

Building Research	**5s. 6d.** (*post* 5*d.*)
Forest Products Research	**6s.** (*post* 5*d.*)
Pest Infestation Research	**5s.** (*post* 5*d.*)
Radio Research	**3s. 6d.** (*post* 4*d.*)

HMSO

from the Government Bookshops or through any bookseller

A DICTIONARY OF STATISTICAL TERMS

M. G. Kendall and W. R. Buckland

This dictionary consists of two parts, a dictionary of terms and definitions in English, and four glossaries of equivalent terms (without definitions) for each of the four languages, French, German, Italian, and Spanish. Over 1700 terms are defined.

25s. net

A DICTIONARY OF SCIENTIFIC TERMS

6th EDITION

I. F. and W. D. Henderson

For this new edition the text has been extensively revised and extended to give the pronunciation, derivation, and definition of over 14,000 terms in Biology, Botany, Zoology, Anatomy, Cytology, Genetics, Embryology, and Physiology.

32s. net

Oliver and Boyd

Tweeddale Court **Edinburgh 1**

Embryos and Ancestors

SIR GAVIN DE BEER, F.R.S.

Darwin emphasized the important connexions between Embryology and Evolution, and the centenary of the first presentation of his theory is an appropriate occasion for the appearance of this new edition. Among other topics discussed are the varying rate of change among different groups of organisms, and the reasons for gaps in the geological record of fossils leading to such groups.

With plates and text-figures
Third edition 25*s. net*

Climatology

TREATED MAINLY IN RELATION TO DISTRIBUTION IN TIME AND PLACE

W. G. KENDREW

'. . . undoubtedly a work of scholarship and one of the most important books on the subject published in recent years. . . .'
Weather

Second edition
Illustrated 42*s. net*

OXFORD
UNIVERSITY PRESS

first translator's insufficient grasp of the original. For instance, where Stenger correctly speaks of Schulze's placing objects *on* a glass bottle containing a mixture of chalk and silver nitrate, the translator makes him say that Schulze put objects "*into* a glass. . . ."

Despite these necessary criticisms, "The March of Photography" is an admirable storehouse of information and makes very interesting and entertaining reading.

H. GERNSHEIM

Artificial Stimulation of Rain

Proceedings of the First Conference on the Physics of Cloud and Precipitation Particles, held at Woods Hole, Massachusetts, September 1955. Edited by H. Weickmann and W. Smith (*London, New York, Paris, Pergamon Press, 1957, xvi+427 pp., 250 figures, 31 tables, £5 5s.*)

In the past few years great interest has arisen in the possibility of modifying the physical state of natural clouds by artificial means, such as the introduction of foreign nuclei, and in attempts to exploit such techniques to produce economically important increases in rainfall. Despite claims that have been made in some quarters, the efficacy of large-scale seeding has yet to be firmly established, but the hope of ultimate success has undoubtedly stimulated research into the formation and constitution of clouds and the physical processes involved in the precipitation of rain, snow, and hail.

At a conference held at Woods Hole, Massachusetts, in September 1955, many leading American and Canadian experts in cloud physics and related fields met to discuss the results of their recent researches.

In this handsome volume, the papers, forty-eight in all, are grouped into four sections with a report of the ensuing discussion placed at the end of each contribution. Part 1 deals, for the most part, with properties of the natural atmospheric aerosol, especially with the nature, origin, size-range, and behaviour of the various types of suspended particles and nuclei, and with their distribution in the atmosphere over land and sea. Special techniques developed for the collection and identification of particles as small as the nuclei of condensation are described, and interesting observations bearing on Bowen's suggestion that meteoric dust particles may act as highly efficient freezing nuclei are reported.

The papers in Part 2 constitute a fairly comprehensive account of recent work, both experimental and theoretical, on the micro-physical processes of condensation, droplet growth, and coalescence. These stages of the rain-forming process are being studied intensively both in the laboratory and by sampling natural clouds from aircraft.

There follow papers on the growth of ice crystals and on their aggregation to form snowflakes which, on falling into the warm region of a cloud may melt and reach the ground as raindrops. Radar has provided the cloud physicist with a powerful tool, and important new information on precipitation growth and on the melting zone, derived by this means, is discussed here by leading investigators.

A clear understanding of the mechanisms by which foreign nuclei can initiate the crystallisation of supercooled clouds and knowledge of the properties which govern their efficiency are of particular interest and importance in relation to the artificial stimulation of rain. These matters are considered in the fourth group of papers where many results of new studies on ice-nucleation and crystal growth are discussed in some detail. A completely satisfactory explanation of the ice-nucleating ability of silver iodide and other compounds has yet to be found, but these papers do suggest clues to the surface properties which control nucleation.

A short contribution on thunderstorm electricity concludes the collection of papers, and a brief discussion of the revised international definitions of hydrometeors is appended.

To the reviewer it seems curious that not one of these papers touches on the crucial question of the transport of particles released near the ground up to regions where they can act as ice nuclei.

A symposium publication must inevitably lack the coherence and continuity of a systematic treatise, and is mainly intended for the dissemination of new ideas in a rapidly developing subject. In spite of some delay in publication and a discouraging price (not indicated on the book!) this volume should do much to achieve that objective. It will be of most value to cloud physicists, meteorologists, and geophysicists, but it will also interest scientists working in the allied fields of nucleation phenomena, crystal growth, and aerosol physics.

W. R. LANE

Harvard Case Histories in Experimental Science

Edited by James Bryant Conant. In two volumes (*London, Oxford University Press, 962 pp., 80s. the set*)

These "Case Histories" have a sound basis and laudable intention. It is argued, very reasonably, that the complexity of science is now such that the uninformed visitor could gather very little from a visit to a modern laboratory. The difficulty would be very much less, however, had the visit been made a century or more ago, when both ideas and apparatus were simpler. In these two volumes the attempt is therefore made to give the reader a sort of conducted tour of laboratories in which researches of historic importance were being carried out, much of the narrative being taken from the contemporary publications of the scientists concerned.

So far so good, but to what extent is the attempt successful? In your reviewer's opinion it is only partial. The "Case Histories" were originally prepared for students of the humanities and social sciences at Harvard. At this sort of level they are unquestionably excellent, though still fairly stiff going for those with no scientific background, and can be warmly recommended. But the purpose of publishing them is stated to be that of attracting a wider readership, and it is doubtful how far they will succeed in this respect. The treatment is sometimes very detailed for the layman. The technique of prolonged quotation from the works of 18th- and 19th-century scientists, and some earlier ones, is not always satisfactory for not all were models of clarity, particularly (and understandably) when they were struggling with conceptions they had not fully clarified in their own minds.

The "Case Histories", eight in all, range widely, from the overthrow of the phlogiston theory to Pasteur's and Tyndall's work on spontaneous generation, from the concepts of heat and temperature to the relationship of plants with the atmosphere. They will be very useful to the student of the history of science and to the reader with a good general educational background who is prepared to go to some considerable effort to understand how modern science arose. But in the main this is a work preaching to the converted, and the number of new converts won is likely to be small.

T. I. WILLIAMS

Anare: Australia's Antarctic Outposts

By P. Law and J. Béchervaise (*Oxford University Press, 1958, 152 pp., 45s.*)

Arctic Riviera: North East Greenland

By E. Hofer (*Berne, Kümmerley & Frey, 1958, 125 pp.*)

Midst the spate of recent news from all the scientific stations in the Antarctic working for the International Geophysical Year, we are apt to forget that Australia has, for over ten years, been maintaining small stations on her sub-Antarctic islands and the sector of the continent administered by her.

The story of these Antarctic outposts now appears, told by Phillip Law, Director of the Australian National Antarctic Research Expeditions (ANARE), and John Béchervaise, one of his field leaders. It is a story, modestly told, of great risk and high endeavour in those seas which, in Captain Cook's delightful phrase, are "so pestered with ice that the land is thereby inaccessible".

In an introduction the senior author describes the history of exploration there which led up to the national project of continuous occupation. The main book then takes up the story of the various stations illustrated by excellent photographs. In the attempt to cover so much ground over so many years the arrangement of articles is perhaps a trifle scrappy, but the reader will find no real difficulty in jumping from polar ships to penguin parades and thence to the birth of an iceberg. He will realise that life on the lonely Heard Island, where calm and sunshine can only be expected once a month, is far more unpleasant than at Mawson, the station on the continent itself, a thousand miles farther south. He may consider that a monthly glimpse of the grandeur of Big Ben, the smouldering volcano on the island, as shown in the photographs, would endure in the memory longer than the vast landscapes of the continental ice-cap.

There are sections covering most of the activities of the stations, and the brief descriptions of the scientific work are couched in simple language suited to the ordinary reader.

The pictures of men at work with the instruments show a new fashion in beards. Forty years ago an Antarctic explorer kept his beard as short as possible, using the medical-box scissors if necessary, as any luxuriance gathered ice from the breath which was either embarrassing or painful. That trouble seems to have been surmounted and the bushiest beard is now *à la mode*. The brief articles on sledge-dogs, on the seals and the birds, handsomely illustrated, will titillate the reader's fancy to read and see more of these lighter aspects of an otherwise somewhat monotonous life in the Antarctic. "Anare" is an admirable preview of the kind of work which is now being done at the later and larger scientific stations scattered over the continent.

Nowadays photography is the handmaiden of all exploration, but only once or twice in a generation does the supreme camera-artist appear in the guise of explorer. Perhaps the greatest was Herbert Ponting of Scott's Last Expedition, but he now has a most worthy successor in Ernst Hofer, of the Swiss Topographical Service, who was lent to Dr Lauge Koch, for aerial photography in East Greenland.

In "Arctic Riviera" Hofer has produced at once a masterpiece in photography and a revelation of what Arctic scenery may include. Greenland's icy mountains are there of course, but so too are verdant patches of Arctic flowers. Majestic icebergs glowing in orange colours from the setting sun alternate with the homely faces of the Greenlanders, or the noble sweep of vast glaciers breeding myriads more icebergs of every shape and size. One turns from the sheer beauty of a coloured picture of ice and sea to the slightly odd obliques from an aeroplane of serried peaks and again to the really queer appearance of pseudo-volcanoes in mud caused by thawing. The author ranges cleverly from the landscape which shows so much detail that it is confusing to the eye to the simplicity of a portrait of a Greenland boy or a close-up of flowers.

With the wealth of illustrations there is a clear description of that part of East Greeland by the veteran Dr Lauge Koch himself, followed by a simple, friendly and humorous résumé of Hofer's four summer visits, in which he fully justifies his choice of title, provided always that one is thinking of the summer only.

F. DEBENHAM

The Planet Jupiter

By B. M. Peek (*London, Faber & Faber, 1958, 280 pp.+16 plates and index, 42s.*)

It is well known that in astronomy the amateur has contributed a sound and vast body of information. His equipment compared to that of the professional astronomer is limited both in physical size and in the amount of ancillary apparatus which can be used with it. Yet while the professional astronomer using the largest telescopes in the world penetrates ever farther into space, the work of the amateur deals with those objects which either lie nearer home or which do not require immense apertures for their successful observation. From the point of view of studies of detail, photographic observations of the planets are disappointing; the image on the photographic plate has to be built up over a long period of time and during such an extended exposure the little disk of the planet has the fine detail obscured by the ever-changing currents of air which lie between the telescope and the upper reaches of the Earth's atmosphere. But there are moments of temporary stillness of the air and it is these transitory pauses —which the observer calls "good seeing" —where the visual observer scores. It is these moments which the amateur astronomer uses and from a succession of which he is able to build up a picture of the fine detail on a planet's disk. The work of amateurs has been of a very high standing and especially that carried out by members of the British Astronomical Association. In 1934 Mr Peek became Director of the Jupiter Section of the Association and under his guidance, as under the guidance of his predecessor, the Rev. T. E. R. Phillips, the contribution of the British amateur to the study of Jupiter has become world-famous. Now Mr Peek has written a book which is virtually an encyclopedia of Jupiter and contains the complete story so far of the work carried out on this planet and the results which have arisen from it.

The book is divided into four parts. The first, an introduction, contains general remarks on the subject, gives the nomenclature used in the study of the planet and contains also a glossary of astronomical terms. The second part deals in detail with the actual observations which have been made of the planet and is illustrated by observers' drawings. Photographic observations are next discussed and their limitations as well as their advantages for certain specialised work are noted. One of the great uses of photography in planetary work is to obtain images of the disc using various coloured filters, and from these obtain information not available by direct visual observation; this Mr Peek well illustrates.

The theoretical considerations which arise when the observations themselves have been sifted form the third part of the book. Mr Peek's own views on the nature of the Great Red Spot are, of course, included. Part Four is concerned with the satellites of the planet. At the end of the book there are appendices giving information vital to the observer and student of Jupiter, while there is also an excellent index.

Mr Peek has written a book which for the first time contains all the information available on Jupiter and has written in a style which is not only easy and pleasant to read but also imparts to the reader something of the thrill and enthusiasm which are found by those who carry out this kind of work. Moreover throughout the whole book it is clear that we have an able scientist writing for us about his own subject and there is, at all times, a real humility underlying the bare words of the text.

This book will indeed become a classic and should not only be in the library of every planetary observer but also in that of every astronomer. But that is not all. Mr Peek has written a book which will prove interesting and profitable to those whose scientific work lies in other disciplines or even those whose scientific knowledge is but very slight, for here we have attractively laid out before us the raw material on which experimental science is based.

The book is well printed and well illustrated and is much to be recommended.

C. A. RONAN

Brief Note

The Ninth Annual Report of the Commonwealth Scientific and Industrial Research Organisation for the year ending June 30, 1957, has recently been published.

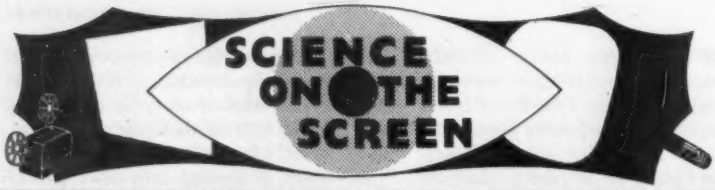


FIG. 1. The Shell Film Unit setting up on the edge of the Snowy River behind Mount Kosciusko. Behind the Unit are the two Sno-cats they used to traverse the snow country.

FIG. 2. French tunnellers coming off shift at the T1 tunnel.

The Forerunner

Australia is a land where almost every year one part or another of the country is scourged by either fire or water, or both.

But while bush fires are spectacular and cause widespread damage, fire is not the greater problem. This position is reserved for water. There is either too much of it or not enough.

The Forerunner, a 37-minute black-and-white film, was written and directed by John Heyer (maker of the film, *The Back of Beyond*). It sets out to give, as the sub-title says, "three impressions" of Australia's water problem and what is being done to remedy it. But to describe the three sequences as "impressions" is surely a modest understatement, for they practically brand themselves on the retina.

We see first what happens when rivers on the eastern seaboard, swollen by the swift, unchecked run-off following torrential rains, rise and flood the towns and countryside. There is no commentary in this sequence, for none is needed. An avalanche of water pushing all before it —cars and cattle, house and home— engulfs the town and having struck, passes to leave a still murky sea on which float a few pathetic remains.

The waters fall to leave a ubiquitous slime to be baked by the sun. It hardens and cracks and we are in the middle of a drought, spectators to the scene as thirsting gaunt animals stagger to the last remaining puddle. A family loads its possessions into a sulky and abandons its homestead to the desert-dwelling reptiles.

Having thus vividly presented the extreme aspects of the problem, the film goes on to deal with the first stage of the solution: the "forerunner" of the film's title, a gigantic engineering project known as the Snowy River scheme by which water from some of the east-flowing rivers will be diverted to the West, thus checking the wilder extravagances of an arbitrary nature. From this project will come hydroelectric power for industry and life for the western lands.

With the simplicity and economy of true art, Heyer shows just how vast the Snowy River scheme is. Bulldozers work among the great trees of the valley forests preparing the way for the gigantic walls of dams and reservoirs. A group of men tunnel deep into the basalt mountain core, watched by a malevolent Nature in the form of a toad. Far above them on the bare crown a survey party pushes through a raging blizzard.

Here then is a film which deals at first sight purely with triumphing technology. But because of the skill of the director it becomes something more than a merely

good documentary. The forces of Nature and of Man are the protagonists here and their clash and resultant reverberations have been used with compelling artistry.

J. SIMONS

3-D Mathematical Colour Film

"To see in relief is to receive by means of each eye the simultaneous impression of two dissimilar images of the same object."

Mr Trevor Fletcher (Lecturer in Mathematics, Sir John Cass College) read this quotation as a very adequate description of 3-D when introducing his latest mathematical film at a meeting of the Scientific Film Association, at the Mezzanine Cinema, Shell Mex House, on May 29. Appropriately, the quotation was attributed to Euclid about 280 B.C.—appropriately because Mr Fletcher's latest film is believed to be the first three-dimensional animated film concerned with mathematics.

Outlining the development of stereoscopy, Mr Fletcher remarked that experiments had been conducted as far back as the 16th century; that Whetstone had devised a crude system of stereoscopic moving pictures in London in 1832 (the device was in the Science Museum and regrettably did not really achieve its object), and the first camera Friese-Greene used in 1893 recorded stereoscopic pictures.

The British had made some notable contributions to the presentation of mathematical concepts on film, but it should not be forgotten that as far back as 1912 Münch had made eight mathematical films in Darmstadt, some on subjects which it would be very valuable to have recorded on film today.

Another German, Max Elver, in 1922 formulated certain principles which Mr Fletcher believed were the basis of a sound approach to the production of mathematical films.

(1) Mathematical films should help when powers of thought or of visualisation meet difficulties, and not seek to supplant logical thinking which is also necessary in mathematical instruction.

(2) They should be used when exact drawing with chalk is difficult or too tedious, and should aid and correct visual powers.

(3) They should only present material which cannot be presented better in other ways.

(4) The film should not seek to present artistic or surprise effects but only phenomena which are strictly concerned with mathematics itself.

Mr. Fletcher's film showed moving coloured diagrams of the lines of force when electromagnetic oscillations take place in resonant cavities. The nodes of oscillation are known to electrical engineers as H.101, E.111 and H.111, and presenting the diagrams stereoscopically on moving film brought out features of the oscillations which it would be most difficult to grasp from a study of the mathematical equations alone.

The film had been shot on 16-mm. Kodachrome, two pictures being recorded side by side on each frame. Thus, when superimposed on the screen they give the equivalent of a 8-mm. stereoscopic film image. Whilst this had drawbacks in terms of illumination and definition, it had many practical advantages. The films could be made with simple equipment and, more important for the teacher, could be projected with a conventional 16-mm. projector fitted with a Paillard Bolex stereo lens. A metallised screen is essential, but this need not deter the teacher since a sheet of plywood painted with aluminium paint will serve the purpose very well.

The resultant stereoscopic image is excellent in a small lecture room, and indeed the picture screened at the Mezzanine Cinema was very good, although the auditorium seats more than 100 people.

The meeting concluded with a screening of the experimental film, "Power in Perspective", made by the Shell Film Unit in October 1955 to demonstrate the capabilities of the Spottiswoode 35-mm. 3-D camera.

Television During June

Four school programmes were broadcast in June by the BBC under the common title "Living in Water". These were lecture demonstrations combined with film, given by J. Carthy and produced by Miss F. Elwell. Although the biology was admirably presented throughout, there were occasional lapses in the lecturer's presentation of applied physics. In describing jet propulsion, for example, a good experimental illustration with a balloon was followed by an unfortunate error in describing the mechanism of jet propulsion mechanics. Admittedly the error was not too serious, yet it was undesirable in a school broadcast. The attractiveness of the rest of the programme more than compensated for the slip.

The fourth programme in this series, on June 30, entitled "How Water Animals Breathe" started off on the wrong foot with a statement that solar energy is derived from the "blowing up of atoms". This is a somewhat irregular description for thermonuclear synthesis, but once the biology began, the programme was fascinating and a surprising amount was packed in, without overcrowding, largely because of the compact unity of material. Insects which come to the surface for air, such as mosquito larvae, were shown in action. There followed attractive live illustrations of air-storing water insects; then we were shown progressive stages of gill development by means of some excellent action films on the axolotl, the sea-slug, and the goldfish. Of particular didactic value was a recapitulation at the end, with additional film illustration.

Some excellent microscope film of moving paramecium was shown. And here I should like to protest against the misconceptions often created by the showing of microscope film. One sees these sluggish animals, *apparently* darting about at high speed, merely because the distance moved per second is so magnified. Yet in all the numerous lectures, demonstrations, and broadcasts that I have witnessed wherein this effect arises, never once have I come across a lecturer who has taken the trouble to explain to his audience that these fast-moving images really are slow-moving animals. I am quite certain that all of the children who saw the excellent shots of paramecium automatically acquired the impression that they were fast-moving objects, which of course they are not, for I have met many university students who hold this mistaken impression.

The relation between time-scale and distance-scale is usually ignored in television broadcasting, probably, for the most part, because the broadcasters are not aware of these peculiar effects. As I have just pointed out, one effect is to give a false impression of high velocity when moving objects are shown through a microscope. But I have also noticed, much to my amusement, an apparent *reduction* in velocity, and quite often too.

For instance, the telephoto lens on a television camera gives a false impression of distance: it *shrinks* distances considerably. With the camera in line-of-sight, down a cricket pitch, the distance between the wickets seems, because of this, far *less* than 22 yards. A fast ball taking about a fifth of a second to cross over, would have a real speed of 110 yards a second, but if the distance *looks* as if it were only 5 yards because of the optical defect of the lens, then we get the *impression* that the speed is only 25 yards a second. We think it is a very slow ball, and are incredulous when the wickets fly, being convinced that we ourselves would have smashed that soft one to the boundary.

I would therefore like to make a special request and ask users of the microscope and of the telephoto lens in any television science broadcasts to bear in mind the space-time relationships of their medium, and always to explain to a lay audience the curious phenomena that can arise. In no sense should one be misled by the

old tag that "seeing is believing" when optical instrumentation intervenes between object and eye.

Independent Television steadily pursue their valuable schools science broadcasts under the generic title "Easier Living". The broadcast on June 10 "The Thread of the Story" by J. Frankau and a scientific advisor was a film containing some delightful material on silicones. The method of presentation is perhaps open to some criticism, although the content was of itself most attractive. The broadcast consisted throughout of the voice of John Richmond in the background either dubbing prepared film, accompanying silent film, or describing experiments carried out by others. To maintain the fiction, the faces of the experimenters were never shown, only their hands, for in fact they were not doing any of the talking or describing; this was all ably handled by John Richmond. There is no doubt that this made for an artificial set-up, but perhaps I am putting an adult interpretation on this: maybe the children never even noticed the trick imposed on them.

The content of the broadcast was most ably selected. Good, trim, film sequences were shown in rapid succession, illustrating the rheological properties, thermal properties and water-repellant properties of some typical silicones. Just enough simple chemistry was included to add instruction to interest. Any teacher who has to deal with the elements of surface tension, whether in school or university, could have derived benefit from this. This was altogether a valuable and admirably illustrated broadcast.

It would be a good thing if both BBC and ITA recorded all their school science broadcasts on films and put them out for adults as late evening extras, the science programmes intended for adults, being so sparse and irregular. Surely science and technology are of sufficient importance to justify a firm weekly allocation. So much is owing both to the scientists responsible for the evolution of broadcasting and to the vast viewing public who benefit from technology.

S. TOLANSKY

Explorer Making Films for BBC Television

The well-known Norwegian explorer, Hr Per Høst, whose big film about the Lapps has been seen by millions on the BBC television, is now preparing another series of films for British viewers. Initiated by BBC's own Peter Scott, the ornithologist, it is to be a popular-science series about the flora and fauna in the Oslo Fjord. At the same time, Hr Høst is making a big film about Norwegian marine research.

Hr Høst also has an expedition working in South America collecting material to be made into another ethnological series to be shown on BBC television at the beginning of next year.

Classified Advertisements

APPOINTMENTS VACANT

THE MANCHESTER COLLEGE OF SCIENCE AND TECHNOLOGY

(Faculty of Technology in the University of Manchester)

APPOINTMENT OF RESEARCH ASSISTANT

APPLICATIONS are invited for the post of Research Assistant in the Department of Physics. The person appointed will be required to take part in the research of the Department which is at present concerned with x-ray diffraction, physical optics, electronics and instrumentation, and will be expected to become a candidate for the degree of Ph.D. Applicants should, therefore, have a good Honours Degree in Physics and some research experience, not necessarily related to the subjects mentioned above.

Salary scale: £575 × £25–£600 per annum. Superannuation under the F.S.S.U. Family allowances.

Forms of Application may be obtained from The Registrar, The Manchester College of Science and Technology, Manchester, 1, to whom they should be returned not later than September 20, 1958.

ELECTRONICS ENGINEER

COURTAULDS LIMITED invites applications from graduate ELECTRONICS ENGINEERS. The successful applicant will be about 25 years of age and will be familiar with digital computer techniques or have had experience in the development of industrial electronic measuring and control systems. The work he will do will be unusually varied and interesting.

Candidates should write for a detailed form of application to the Director of Personnel, Courtaulds Limited, 16 St Martins-le-Grand, London, E.C.1, quoting reference number C.99.

LECTURES AND COURSES

UNIVERSITY OF LONDON

DEPARTMENT OF EXTRA-MURAL STUDIES

UNIVERSITY EXTENSION COURSES IN SCIENCE

Beginning Autumn 1958

1. The Understanding and Criticism of Science
   23 lectures (for graduates).
2. Biochemistry for Biologists
   10 lectures (for graduates).
3. Heredity and Behaviour in the Animal Kingdom.
   24 lectures.
4. Science and the Course of History.
   25 lectures.
5. Cosmology.
   24 lectures.
6. Rock Magnetism and the Movement of Continents.
   10 lectures.
7. The Natural History of Britain.
   27 lectures.
8. Biology and Religion.
   12 lectures.
9. Modern Aspects of Nutrition.
   12 lectures.

Full particulars of these courses can be obtained from the Deputy Director (Ext. D), Department of Extra-Mural Studies, University of London, Senate House, W.C.1.

FARADAY HOUSE
ELECTRICAL ENGINEERING COLLEGE

A THREE-YEAR COURSE, commencing each term, in Electrical Engineering to qualify for Associate of Faraday House and Graduate of the Institution of Electrical Engineers, followed by one year's practical training in Industry to qualify for the Diploma of Faraday House. For Prospectus apply to Department "E", Faraday House Electrical Engineering College, 66 Southampton Row, London, W.C.1.

PUBLICATIONS

THE HUMANIST is the journal of Scientific Humanism (monthly 1s., p.a. 14s.) Spec. copy, "Living with Reality", and Bertrand Russell's "Faith of a Rationalist", free. RPA, 40 Drury Lane, W.C.2.

SOCIETIES

THE BRITISH INTERPLANETARY SOCIETY

12 Bessborough Gardens,
London, S.W.1

MEMBERSHIP and Fellowship is open to all interested in space-flight, rocket engineering and astronomy.

Full particulars of membership, together with a free copy of the Society's Journal and programme of lectures in London and many provincial towns, will be sent on request.

TEACHING

VACUUM PHYSICS . . .
INDUSTRIAL PRODUCTION
NATURAL PHENOMENA ?

The immense value of VISUAL AID in modern teaching is strikingly illustrated by the "SPEEDIVAC" EDUCATIONAL UNIT, EQ.2. Many of the basic laws of physics and the phenomena of low-pressure applications can be easily and quickly demonstrated with this SELF-CONTAINED unit.

The unit can also be put to practical work in the laboratory.

EDWARDS HIGH VACUUM LTD

MANOR ROYAL · CRAWLEY · SUSSEX

CRAWLEY 1500 (10 lines) EDCOHIVAC, CRAWLEY

REDUCE SPOILAGE

with the MORANE Transparent PLASTIC PROTECTION PROCESS

Morane Protection reduces spoilage and keeps all kinds of documents and printed matter preserved against damp, dirt, grease, finger markings and damage.

This simple treatment consists of sealing the material between two sheets of transparent plastic skin, which operation is easily carried out by unskilled labour.

Save time, money and spoilage: send the coupon below for complete specifications and details, or for advice on a particular problem you have.

PRESERVE DOCUMENTS, NOTICES, DRAWINGS, BLUEPRINTS, AND ALL PRINTED MATTER *INDEFINITELY* AGAINST DAMP, DAMAGE, DIRT, GREASE AND FINGER MARKING

MORANE PROTECTION *IS HYGIENIC AND WASHABLE*

Samples and information will be gladly sent and heat-sealing demonstrations arranged

Send coupon to

MORANE PLASTIC Co. Ltd.

21 Woodthorpe Road Ashford, Middx.

Agents for Scotland,

The Mora Company 289/291, Eldon Street Greenock, Renfrewshire.

NAME.....

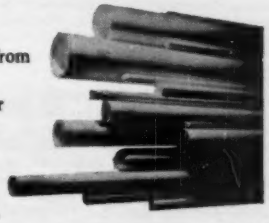
ADDRESS.....

.....

D3

'Triangle'
RECRYSTALLISED ALUMINA
99.7% Al_2O_3

This is Morgan Refractories recrystallised alumina; the purest available anywhere in the world. It is hard, extremely resistant to abrasion and mechanically strong; tubes, crucibles, trays can be made very thin, and therefore relatively immune to thermal shock.
Recommended maximum service temperature—1950°C.
Thermal conductivity at 1000°C 40 BThU sq. ft./hour.



Standard tubes are available from stock up to 65 mm. bore, but we make very much larger tubes—up to 165 mm. bore, which are the largest made anywhere in this material.

Send for catalogue Ref. RD79.

MORGAN Refractories Ltd

NESTON · WIRRAL · CHESHIRE

M140

Classified Advertisements

OFFICIAL APPOINTMENTS

ANTARCTICA

WIRELESS OPERATOR MECHANICS required by FALKLAND ISLANDS DEPENDENCIES SURVEY for service at isolated British bases in Antarctic. Must be able transmit and receive Morse at 20 words a minute and be capable elementary maintenance wireless transmitting and receiving equipment. Salary according age in scale £330 rising to £420 a year with all found, including clothing and canteen stores. Keen young men between 20 and 30 years required, preferably single, of good education and high physical standard, with genuine interest in polar research and travel and willing to spend 30 months under conditions testing character and resource. Successful candidates will sail in October. Write to the Crown Agents, 4 Millbank, London, S.W.1. State age, name in block letters, full qualifications and experience, and quote M2C/42653/DI.

SENIOR SCIENTIFIC/SCIENTIFIC OFFICER required by
THE ATOMIC WEAPONS RESEARCH ESTABLISHMENT, ALDERMASTON, BERKSHIRE

To carry out research on basic methods of instrumentation, including the specification of apparatus.

1st or 2nd Class Honours Degree in Physics or Physical Chemistry, or equivalent, required. This is a practical post and requires a wide knowledge of physics rather than specialisation, although some experience of optics may be an advantage.

Salary: S.S.O. £1215–£1425 p.a.

S.O. to be assessed according to qualifications and experience within the range of £645–£1120 p.a.

Contributory Superannuation scheme. A house or assistance towards legal expenses on house purchase will be available for married officers living beyond daily travelling distance.

POSTCARDS for application forms to the Senior Recruitment Officer at above address. Please quote ref.: A 1783/47.

UNITED KINGDOM ATOMIC ENERGY AUTHORITY

(Industrial Group)

SCIENTISTS, TECHNOLOGISTS and EXPERIMENTALISTS

are needed by the

RESEARCH AND DEVELOPMENT BRANCH

FOR POSTS ATTRACTING SALARIES RANGING FROM
£520 to £2080 per annum

Applicants should be qualified by training and experience for work on applied research and development associated with vital new projects which are expected to bring about further significant

ADVANCES IN NUCLEAR TECHNOLOGY

which will enable the country's present lead in the development of atomic energy for industrial use to be maintained.

In the large modern laboratories operated by the Research and Development Branch associated with the major atomic energy plants and reactors, research scientists are able to link the results of their work directly with new developments in plants, processes, design, and operation.

The locations and main fields of work of the laboratories are:

WINDSCALE

(on the West Cumberland coast),
the centre of the Industrial Group's experimental work on gas-cooled reactors, where experimental reactor assemblies are being provided to extend the work on reactor physics. Research work is also done on fundamental heat transfer problems and their application to reactor cooling, whilst a solid state physics group is concerned with irradiation experiments on fuel elements and reactor materials, and a large chemical engineering laboratory is engaged on the development of new processing methods. Here there are opportunities for Reactor, Experimental and Theoretical Physicists, Metallurgists, Development, Experimental and Chemical Engineers, and Inorganic and Physical Chemists.

SPRINGFIELDS

(in the Fylde District of Lancashire),
the centre of Fuel Element Technology for the National Nuclear Power Programme. The development of extraction, processing and fabrication techniques for nuclear fuels and special canning materials, and the evaluation of fuel elements, provide opportunities for Physical and Process Metallurgists, Ceramicists, Classical and Metal Physicists, Physical Chemists and Chemical Engineers.

CAPENHURST

(on the Wirral, Cheshire),
the centre for development work on diffusion plants and engineering. Research groups study the physics of isotope separation processes, bearings, seals, and compressors for energy applications and fluorine chemistry. There is also a large laboratory for the development of instrumentation for the Industrial Group. Classical, Theoretical and Instrument Physicists, Development, Experimental and Instrument Engineers and Physical and Inorganic Chemists are required.

CULCHETH

(in South Lancashire),
the centre for the development of steels and engineering materials, and investigations into compatibility of materials and corrosion. There are openings for Metallurgists, Classical and Metal Physicists and Physical, Inorganic and Analytical Chemists.

RISLEY

(in South Lancashire),
where a large number of technical assessments and calculations are carried out in aid of the design and operation of reactors and process plants by Reactor, Theoretical and Mathematical Physicists, Engineers, and Metallurgists. The teams are supported by an electronic computer group, which provides opportunities for Mathematicians (Computer Programmers).

There is a staff housing scheme at each location.

Application forms and information leaflets can be obtained from the

SENIOR RECRUITMENT OFFICER, UNITED KINGDOM ATOMIC ENERGY AUTHORITY, INDUSTRIAL GROUP HEADQUARTERS, RISLEY, WARRINGTON, quoting reference 2560.

Closing date: September 19, 1958

SENIOR SCIENTIFIC OFFICERS (*a*); SCIENTIFIC OFFICERS (*b*). Pensionable posts for men and women in major scientific fields, including meteorology and geophysics (frequent overseas surveys). A few vacancies for biologists, including specialised posts in taxonomy of invertebrate animals, fungus systematics, and one post for a taxonomic botanist (Pteridophyta). Also one post in Home Office for Mathematician/Physicist to work on Civil Defence problems. Qualifications: normally first- or second-class Honours Degree in science, mathematics, or engineering, or equivalent attainment; additionally, for (*a*) at least 3 years' relevant (e.g. post-graduate) experience. Normal age-limits: (*a*) between 26 and 31, (*b*) between 21 and 28, with extensions for regular Forces service and Overseas Civil Service. London salaries (men): (*a*) £1190–£1410, (*b*) £635–£1110. Five-day week generally. Write Civil Service Commission, 30 Old Burlington Street, London, W.1, for application form, quoting (*a*) S.53/58, (*b*) S.52/58.

COLONIAL OFFICE, TROPICAL PRODUCTS INSTITUTE, LONDON, W.C.1, requires SENIOR SCIENTIFIC OFFICER (Physicist) for Fibres Section (concerned with production, examination and utilisation of animal and vegetable fibres of all kinds, particularly of tropical origin). QUALIFICATIONS: B.Sc., 1st or 2nd Class Hons.; preferably some experience in textile industry or fibre research. SALARY according to age and experience in scale (London Weighting included) £1190–£1410 (Women's scale slightly lower). Unestablished appointment on F.S.S.U. terms; but, if eligible, selected candidate may compete later for established (i.e. pensionable) appointment through Civil Service Commission Open Competitions. (Age limits broadly 26–31). Forms from M.L.N.S., Technical and Scientific Register (K), 26 King Street, London, S.W.1 (Ref. A.297/8A). Closing date September 15, 1958.

HONOURS BOTANIST required for Systematist post in National Agricultural Advisory Service at Faversham. Age (normally) at least 25 on 1/8/58. Qualifications: Honours degree in Botany or General Honours degree with Botany as main subject. An interest in systematics essential. Duties: variety trials of hardy fruits; study of variety collections for nomenclature classification. Starting salary (men) £810 or over, rising to £1280; promotion prospects. House available. Write Civil Service Commission, Burlington Gardens, London, W.1 for application form, quoting 4876/58. Closing date, September 11, 1958.

SOUVENIRS OF ENGLAND

Write for comprehensive list of guide books in colour and black-and-white, fully illustrated, covering a variety of places in the British Isles.

Prices in the 2*s.*–3*s.* 6*d.* range

JARROLD & SONS LTD,
St. James, Norwich

Printed and published in Great Britain by Jarrold & Sons Ltd, Norwich

Editorial Office: 244 High Holborn, W.C.1

The Golder MICROFLEX Eyepiece Camera

now available for

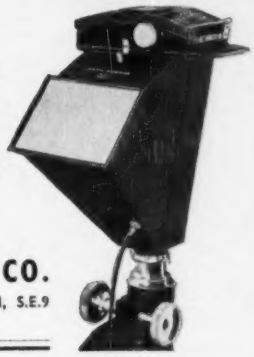
ROLL FILM

The special adaptor and masks provide a choice of

8 2¼″×3¼″, 12 2¼″×2¼″ or
16 2¼″×1⅝″ exposures

on one spool of 120 black and white or **COLOUR** film. Daylight loading. Suitable for all microscopes.

Leaflet RFM9 containing full information from



ALBERT GOLDER & CO.

137 DAIRSIE ROAD, ELTHAM, LONDON, S.E.9
Phone: ELTham 5126

BOOKS AND JOURNALS

We display some 24,000 recent and standard books on all branches of science and technology. Inspection is always invited in our spacious showrooms, which are conveniently situated.

POSTAL SERVICE

We pride ourselves upon speed of dispatch and regularly supply some of the largest industrial undertakings in Britain and overseas. Annual subscriptions taken for any British or foreign journal. Quotations on request.

Our stock includes all the recognised

TEXTBOOKS FOR STUDENTS

also a fine selection of Drawing Instruments, Slide Rules and Stationery

Call, write, or phone

CLAUDE GILL BOOKS

(formerly "Books & Careers")
485 OXFORD STREET, LONDON, W.1
GRO 5664 (5 lines) 1 min. Marble Arch

G.C.E.

B.Sc.

POSTAL TUITION

Wolsey Hall, Oxford (Est. 1894) prepares candidates for correspondence for G.C.E. (Ord. and Adv. Levels) of all Examining Boards; for London University B.Sc., certain subjects at M.Sc. Maths.; B.A., B.Sc.Econ. and LL.B. Also for Secretarial, Statistical, and other professional examinations.

Prospectus

from C. D. Parker, M.A., LL.D., Director of Studies, Dept. WM9,

WOLSEY HALL, OXFORD

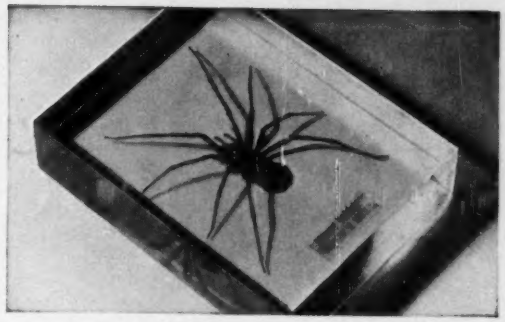
Look at London in Colour

The latest Cotman House publication containing wonderful colour illustrations of the famous places and scenes of historical London

Price **3s. 6d.** (postage **9d.**)

From booksellers or direct:

Jarrold & Sons Ltd, St. James, Norwich, England



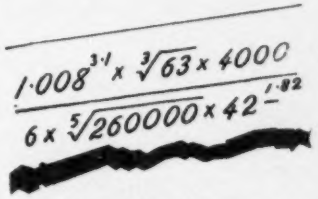
Preserve your specimens in solid transparent plastic

Biological specimens—insects, small skeletons, fish, etc., embedded in a block of Ceemar plastic are completely visible and can be handled indefinitely without injury—ideal for both school classes and advanced students. You prepare them yourselves using the Ceemar kit—a simple technique for any laboratory worker.

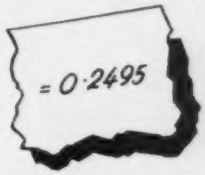
Trial kit 35s. complete with full instructions.
Post paid (in the United Kingdom)

CEEMAR EMBEDDING KIT

Obtainable from the principal laboratory suppliers or direct from
E. M. CROMWELL & Co. Ltd., Rye St., Bishop's Stortford, Herts.



FINDING THE ANSWER



IS SIMPLICITY ITSELF

The OTIS KING Pocket Calculator makes a complex calculation seem simplicity itself. It introduces entirely new features in slide-rule design. By the use of spiral scales mounted on two concentric metal tubes, the graduations of a 66-inch slide-rule are achieved within the compass of an instrument only 6 inches long. Model K quickly solves multiplication, division, percentage calculations with four to five-figure accuracy. Model L gives logarithms as well. U.K. price 57*s.* 6*d.* Non-warping metal construction, with plastic-coated scales. Complete instructions are included with each instrument, explaining the simple three-movement operation. At all leading scientific instrument dealers or on approval by using the form below. Fully descriptive leaflet sent free on request to Carbic Ltd. (Dept. D), 54 Dundonald Road, London, S.W.19.

The OTIS KING Pocket Calculator

Send this form today

To Carbic Ltd. (Dept. D), 54 Dundonald Rd., London, S.W.19.
Herewith remittance for 57*s.* 6*d.* Please send me Model .... Otis King Calculator on your guarantee that if I return it within 7 days, you will refund the money in full.

Name .....
(BLOCK LETTERS, PLEASE)

Address .....

.....

.....

Best of both worlds

When buying furniture, many married couples agree to differ — amicably, one hopes. *He* wants the contemporary look with light-coloured upholstery. ***She*** wonders how, with children climbing all over it, she would ever be able to keep it clean. In the past, this might have seemed a difficult compromise for it would have meant combining the qualities of soft-cover upholstery with the durability and easy maintenance of coated fabrics.

But I.C.I. has now achieved it — by producing an entirely new type of upholstery covering, 'Vynair'. Like all vinyl-coated fabrics, 'Vynair' cleans instantly at the wipe of a damp cloth, but it also regains shape instantly like any conventional upholstery material, for 'Vynair' is a coated cloth with a difference — it breathes!

'Vynair' is available in sufficient colours and designs to accord with any furnishing scheme. In this particular husband-wife difference, 'Vynair' has the last word by combining the best of both worlds.

Thus, and in a thousand kindred ways, I.C.I.'s research and production are serving the Nation.

ICI